With a few simple modifications, an ordinary record changer can be improved to compare with hi-fi types with lowered record and stylus wear and reduced rumble. See page 21.

High-transconductance 80-watt triodes are used by one author in a new output-transformerless circuit to provide a usable output of 20 watts which is used to drive a high-impedance woofer and a condenser-type tweeter. See page 13.

EXPERIENCES IN STEREOPHONY
POINT-CONTACT TRANSISTOR AMPLIFIERS
AN OUTPUT-TRANSFORMERLESS AMPLIFIER-SPEAKER SYSTEM
COMMERCIAL ACOUSTIC SUSPENSION SPEAKER
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Only 4" high—fits anywhere. Beautiful charcoal black marbleized finish with brass control escutcheons. Also easily mountable behind any custom panel. Tuner may be used up to 200 feet from amplifier.

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AUDIO PATENTS

RICHARD H. DORF

Even the best tape recorders and reproducers will not, without special compensation, reproduce sounds in their exact original time relationships. Tape stretch and other small factors accumulate to alter the time relationships so that a program with an original length of 20 minutes and 30 seconds, for example, standard for radio, may turn out to be several seconds long on reproduction. An application where time relationships are particularly important is in the use of magnetic tape for motion-picture recording. When the sounds do not precisely synchronize with the lip movements of actors and the other noise producing phenomena, the effect is very annoying, and since the viewer's ability to detect the lack of synchronization is very acute indeed, some special means must be used to obtain it.

In the past few years several methods of achieving this "lip synchronization" have been used. Almost all of them involving some sort of continuous timing signal on the tape. U. S. Patent No. 2,656,419, issued to Edward N. Dingey, Jr., of Arlington, Va., discloses a new method whose principal distinction is that the same system which corrects for errors in average timing is also used to substantially eliminate wow and flutter, which are short-term timing errors. In this invention the important elements of the recording equipment are shown in Fig. 1. Figure 2 shows the reproducing setup.

The usual elements shown in Fig. 1 are the supply and take-up reels, driven in any of several standard manners, the program source, and the amplifier driving the recording head. The capstan motor, shown by the dashed circle enclosing the capstan and pressure roller, is driven by an a.c. power source, usually the 60-cps line. Note that the wow and flutter which this system eliminates is not that caused by variations in speed of the recording equipment, which is presumed to be the best in terms of quality, but that caused by uneven stretching of the tape and possibly by the playback equipment.

The sole additional feature in the recording equipment is a timing oscillator which generates a timing frequency. This frequency, which may either be above or below the limits of the desired audio band, will be presumed to be 60 cps for reasons which will appear later. If the short-period and long-term stability of the power line is good enough, no oscillator is required. But in most cases the power frequency varies over short periods and an oscillator is preferable. This 60-cps signal is recorded on the tape, along with the program. It is assumed that all the normal elements such as bias and equalization and the like are present but they are not shown so that the invention can be explained in a simple way, without obstructions.

In the playback system of Fig. 2 the usual elements shown are the supply and take-up reels, the playback head and amplifier, and the capstan motor with the capstan and pressure roller. The unusual items in this drawing are the main works of the invention.

Output of the playback-head amplifier goes to the normal output channel through a bandpass filter (or a band-rejection filter) which rejects the timing frequency and thus passes on the program minus the superimposed signal. The timing frequency is fed through a sharply tuned filter to one input of a balanced modulator. To the other modulator input is fed a signal from a timing-oscillator which is either the same one as was used for recording or another which generates the same frequency (60 cps as we have assumed) within very close limits. The output from the modulator is a difference-frequency signal whose phase is proportional to the difference in frequency between the two input signals and thus indicates whether the tape is going slower or faster than when it was recorded.

It is easier, however, to consider that the balanced modulator puts out a d.c. signal whose polarity indicates the difference between record and playback speeds and whose amplitude is proportional to the actual speed difference. This d.c. is fed to a phase-sensitive relay whose plunger is rigidly connected to the lightweight playback head. The head is mounted on rails so that it can...
Since 1935 the Garrard has been sold and serviced throughout the United States.

It is recognized everywhere for superior performance, ruggedness and reliability.

CHECK CRAFTSMANSHIP, FEATURES, PRICE AND SERVICE...
and you will understand clearly why this is the world's No. 1 high-fidelity record changer.

"RIGHTS" and "WRONGS" of record changer design (important in protecting your records).

RIGHT:
Garrard Precision Pusher Platform...
the only record changing device that insures positive, gentle handling of records with standard center holes.

WRONG:
"Overhead Bridges" (as on ordinary changers)...
which may damage or dislodge records accidentally.

RIGHT:
Garrard removable and interchangeable spindles...
easily inserted, accommodate all records, all sizes, as they were made to be played; pull out instantly to facilitate removal of records from turntable.

WRONG:
Fixed Spindles (as on ordinary changers)...which require ripping records upwards over metallic spindle projections after playing.

Other Garrard features include:
- 4 polo meter—no rumble, no induced hum
- Heavy drive shaft—no wow, no waves
- Weighted turntable—flywheel action, constant speed
- Muting switch—silence between records
- Silent automatic stop—shuts off after last record; no disturbing "plop".
- Easy stylus weight adjustment—protects long-playing records

A Quality Endorsed Product of the BRITISH INDUSTRIES GROUP, which also includes

WHARFEDALE LOUDSPEAKERS...designed and built under the personal supervision of G. A. Briggs...world renowned authority on sound. Wharfedale Loudspeakers offer the unique construction feature of cloth suspension—a felt buffer between speaker frame and cone—and cast chassis.

LEAK TL/10—High fidelity AMPLIFIER complete with "Point One" REMOTE CONTROL PREAMPLIFIER. Most economical amplifier combination ever built by Leak. Harmonic distortion only one tenth of one percent. Insures flawlessness of reproduction.

EXCLUSIVE FEATURE! Convenient tape recorder jacks (input and output) on front panel for instantaneous use!

R-J LOUDSPEAKER ENCLOSURES—"Maximum Bass—Minimum Space" Hearing is bellowing! R-J Speaker Enclosures have established an entirely new trend in audio design with thrilling performance from any loudspeaker. Bookshelf and Floor Models.

THE R-J WHARFEDALE... first and only complete R-J until! Two great products—
the R-J single shaft ENCLOSURE and a special WHARFEDALE SPEAKER have been brilliantly matched in this... the definitive combination among compact high-performance speakers.
Is there going to be a U.S.A. Audio invasion of England? Many readers may not realize that U.S.A.-made Audio products are not sold in the British Isles. Since the War when most of our Overseas investments had to be sold to pay for guns and tanks from America, no dollars have been available to pay for luxuries. The only American made products on sale in England are token quantities of those Companies who exported to England before the War and the amounts are so negligible that they are hardly noticed. To overcome these difficulties, some of the leading U.S.A. firms have, in the last few years, established factories in Britain so that they can sell American designed products in the United Kingdom and the Continent of Europe. Manufacturers of business machines, typewriters, and some electrical products are some of the organizations who have established factories in the British Isles, but U.S.A. Audio firms hitherto appear to have neglected the British market.

However, when the British Radio Show opens its doors at Earls Court, London, on August 24th, a name very well known in U.S.A. will, for the first time, have a booth and demonstration room at the Show. It must be strange to U.S.A. readers to learn that R.C.A. is comparatively unknown in England. For some years now they have had a small Company which has been responsible for the servicing and maintenance of their sound equipment for the cinema industry. They are now planning to enter the British market and have acquired a factory near London, in order to manufacture a range of Audio lines.

New High-Quality Amplifier

The first will be a high-quality amplifier with a 12-watt output, somewhat similar in specification to those already made by Leak, Quad, and Pye. The preamplifier will be separate and will be available in two forms, one in a wood case and the other as a bare chassis for installation in a combination cabinet. There will be six control knobs with an ingenious arrangement whereby the knobs do not move across graduations on a scale, but these graduations appear behind illuminated windows on the panel. Other novel points in design will be that all the resistors and capacitors on the preamplifier will be on hinged panels which swing forward for easy servicing. H. T. (plate) and L. T. (filament) supplies...
Encore for a magnificent performance

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You pay only 59¢ for this Exclusive Encore Treasure Tape, "Excerpts from Dubbings Test Tape No. D-110". THE MEASURE OF YOUR TAPE RECORDER'S PERFORMANCE. Tests for maximum and normal recording level, rough and fine head alignment, timing and tape speed, wow and flutter, signal-to-noise ratio. NOT for sale anywhere. Obtainable only by mailing this coupon.

Because of the anticipated demand, this offer is necessarily subject to cancellation or change without notice.

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CITY: ZONE: STATE:

AUDIO • JULY, 1955
HOW YOU CAN ADVANCE IN ELECTRONICS

As a training engineer you will become familiar with the entire systems involved, including the most advanced electronic computers. With this advantage you will be ideally situated to broaden your experience and learning more quickly for future application to advanced electronics activity in either the military or the commercial field.

At Hughes Research and Development Laboratories in Southern California you, as an engineer assigned to this program, will be a member of the Technical Staff. Prior to instructing you will receive technical training to become familiar with the latest Hughes equipment.

The time was never more opportune than now for becoming associated with the field of advanced electronics, because of military emphasis. This is the most rapidly growing and promising sphere of endeavor for the young electrical engineer or physicist.

If you are an electrical engineer or physicist, you can conduct laboratory and classroom programs on advanced systems in the fields of radar fire control, electronic computers, and guided missiles.

Hughes Research and Development Laboratories
Culver City, Los Angeles County, California

RCA are also going to manufacture an FM/AM tuner and some loudspeaker units of which one type will embody a Wharfedale W12/CSAL. Another speaker to be used in the RCA demonstration room at the Show will incorporate two 15-in. Wharfedales, coupled to a reflex horn, 12- and 8-in. Wharfedales, and an RCA high-frequency pressure unit. Other plans that RCA have in mind are the marketing of a tape deck and possibly a pickup. By making these products in England, they hope to be able to sell them through the Companies they established recently in France and Spain. Mr. Angus Walker was unable to give me any information regarding RCA records which hitherto have been pressed in England by E.M.I. and sold under the H.M.V. label. Prior to the War, all RCA records were handled by E.M.I. throughout Europe. In some countries these are now being made in local factories and marketed direct by RCA in these countries.

A recent announcement in the radio trade press has revealed that the Webster-Chicago Corporation have formed a British Company, Webcor (Great Britain) Limited, who claim that before long they will be selling British made record reproducers, tape recorders and record changers.

As there is now virtually no unemployment in this Country, one difficulty which Overseas firms will have to overcome is that of obtaining sufficient and efficient labour. The restriction on the importation of foreign made Audio products does not tend to those manufactured in Europe but few lines reach the English market due to the efficiency of English manufacturers and to import duties.

Neat Tape Recorder

However, one foreign item which has recently won much favour in England is a very neat little tape recorder made by Philips in Holland. The Philips Company which is, of course, one of the largest organizations in Europe for the manufacture of radio and Audio equipment, has some of the largest radio factories in England. Nevertheless, they are importing from Holland this little tape machine which sells for $103. It measures only 13 x 10 x 7 in. and thus it is easily portable. The price includes a crystal microphone, a 600 ft. reel of tape, and an empty reel. These can be left in position on the deck when the lid is closed. An additional reel can be carried in the lid which is detachable and incorporates ingenious methods of holding the mains lead, microphone and cable. The machine is dual track and operates at 3½ ips. It has single knob control with...
separate positions for recording from the microphone and radio.

It is one of the few tape recorders on the British market which operates off all voltages between 110 and 250. The built-in loudspeaker is of 5-in. diameter. Sockets are provided so that recordings can be made from a radio set or pick-up and the output can be extracted before the last stage for feeding to a high-quality amplifier.

This machine, in the opinion of your correspondent, represents the best value of tape recorders in Europe. Whilst it is not claimed that it gives the high-fidelity reproduction which is associated with a more elaborate machine such as the Ferrograph, it does, nevertheless, give reproduction when operated in conjunction with an external loudspeaker which is comparable with the average radio-gramophone combination available on the British market. By clever circuitry, only four valves are used and a special compensation network is incorporated which does much to make up for the loss of treble usually associated with 3¾ ips recording and reproduction.

Audio Fairs

Possibly, because Britain has an Annual Radio Show which is visited by more than a quarter of a million paying members of the British public, there are no Audio Fairs held quite the same way as you have them in the United States. The nearest British event to an American Audio Fair is the annual exhibition of the British Sound Recording Association of which the 1951 Show recently took place at London's Waldorf Hotel. This is a much more modest affair than your American exhibitions of the same kind and had only 26 exhibitors. Nevertheless, it was a very live exhibition and some very interesting demonstrations were given in some of the private rooms of the hotel. Possibly the three most outstanding were those given by Leak, Acoustical Manufacturing, and H.M.V. The Acoustical Manufacturing and Leak demonstrations were really a battle of electrostatic loudspeakers. Harold Leak was demonstrating a prototype of his electrostatic/moving coil loudspeaker unit which, he hopes to have in production and on sale on the British market within three months. This comprises an electrostatic speaker for the treble and a special moving coil 15-in. speaker for the bass. The combined units together with crossover network but without cabinets, he hopes to sell in the home market for $100. The demonstrations which were carried out throughout the days of the exhibition were really most convincing and many people expressed the opinion that this was the highest quality sound they had heard from what will be a commercial equipment.

No additional amplifiers are necessary and the loudspeaker combination was operated from a standard Leak TL/10 amplifier. Visitors were also very much impressed by the Acoustical Manufacturing demonstration. Here, one electrostatic loudspeaker only is used and it is claimed that this covers effectively a range from 30 cps upwards. On the other hand, its development has obviously not progressed quite as far in regard to commercial production. P. J. Walker, Managing Director of Acoustical, told me that he did not expect to be in a position to fulfill orders for 2-3 years. The electrostatic speaker will be made in various sizes, but the one particularly recommended for the highest possible reproduction will be about 8 ft. high and is preferably built in to the wall of a room. Mr. Walker was unable to give me any idea of price, but technical readers of Audio who would like to have more information about both the

(Continued on page 26)
LETTERS

Damping Factor—A New Approach

Sir:

As the one originally responsible for introducing the term "damping factor," I feel some responsibility for finding an alternative form now that we are so deeply in the morass. The term had many shortcomings but it could, at least, be used safely so long as it was always finite and positive. The commercial release of amplifiers with negative damping factors has been very confusing to engineers, to say nothing of the general public. For an increase of 22 per cent in total circuit damping, the "damping factor" increases from 10 to infinity, then returns back from minus infinity to -10. All these extraordinary changes in the damping factor would lead one to believe that something important was happening. In reality, nothing has happened except a slight and steady increase in the total damping. The tricks played by the so-called damping factor are due merely to an unfortunate choice of definition. With this definition, instability occurs when the damping factor $\leq 1$.

The total circuit damping is a function of the total circuit resistance, which is the algebraic sum of the voice-coil resistance (always positive) and the amplifier output resistance (positive or negative). I therefore put forward the following as a much more satisfactory and logical substitute for damping factor:

$$D = \frac{R_o}{R_L + R_o}$$

where $R_o$ is load resistance, and $R_L$ is output resistance of amplifier, and where both $R_o$ and $R_L$ are referred to the same side of the transformer.

The following table is for $R_o = 15$ ohms, as an example:

<table>
<thead>
<tr>
<th>$R_L$ (ohms)</th>
<th>$R_o + R_L$ (ohms)</th>
<th>Damping factor $= \frac{R_o}{R_o + R_L}$</th>
<th>Damping ratio $= \frac{R_L}{R_o + R_L}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>+90</td>
<td>0.2</td>
<td>0.167</td>
</tr>
<tr>
<td>3</td>
<td>+5</td>
<td>0.83</td>
<td>0.09</td>
</tr>
<tr>
<td>1.5</td>
<td>+16.5</td>
<td>0.91</td>
<td>0.09</td>
</tr>
<tr>
<td>0.15</td>
<td>+15.15</td>
<td>0.97</td>
<td>1.0</td>
</tr>
<tr>
<td>0</td>
<td>+15.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>-0.15</td>
<td>+14.85</td>
<td>1.01</td>
<td>10.0</td>
</tr>
<tr>
<td>-1.5</td>
<td>+13.5</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>-5.0</td>
<td>+10.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>-12.0</td>
<td>+3.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>-13.6</td>
<td>+1.4</td>
<td>10.7</td>
<td>10.7</td>
</tr>
<tr>
<td>-14.3</td>
<td>+0.7</td>
<td>21.4</td>
<td>21.4</td>
</tr>
<tr>
<td>-15.0</td>
<td>0</td>
<td>$\infty$</td>
<td>$\infty$</td>
</tr>
</tbody>
</table>

The justification for this change is that at the verge of instability:

$$D = \frac{R_o}{R_L + R_o}$$

It will be seen that the proposed damping ratio is positive and finite so long as instability does not occur. It is also proportional to the actual damping in the circuit. It appears to be the only available function with all the desired qualities.

F. Langford-Smith
Amalgamated Wireless Valve Co. Pty. Ltd.,
Sydney, Australia

Stylus Force

Sir:

In the Phonogram Equipment section in the June issue, you seem to be championing the cause of the advocates of 6-gram standard stylus force. Considering the wear of tires on heavy automobiles vs. those on light automobiles was left as a valid argument for the cause of the 6-gram proponents. This seems to be upside-down logic.

You are comparing rolling friction with sliding friction when you compare automobile tires with phonograph pickup styls. A more appropriate analogy would be the wear produced by a sled on dry pavement. Everyone knows that the more load on the sled, the greater damage done to the runners and the pavement.

There is little point in drawing analogies, since we have proof that a pickup designed to track properly on 1 gram increases the life of the record and the stylus enormously over a pickup designed for six grams. This was demonstrated and documented at the last Audio Fair in New York.

Paul Weathers, President,
Weathers Industries, Inc.
66 E. Gloucester Pike,
Barrington, N. J.

NEW LITERATURE

- Chicago Standard Transformer Corporation, Addison and Elston Avenues, Chicago 18, Ill., announces that its new 1955 catalog is a completely revised and expanded reference book, listing 543 Stanco transformers and related components. Illustrations of each transformer type appear on the same page as its listing, greatly facilitating selection of replacement units. The catalog has a comprehensive classified index and separate headings for each model to assist the user in locating the transformer he needs. Copy of Catalog S-101 may be obtained from Stanco distributors or by writing the factory direct.

- Electro-Voixes, Inc., Buchanan, Mich., is now issuing a new condensed 14-page catalog which illustrates and describes the entire E-V line of audio components and accessories. A special section is devoted to microphones for TV, broadcast, and public-address application, as well as to a number of models for special purposes. Other sections cover high-fidelity speaker systems and matching enclosures, Circotron amplifiers, public-address speaker systems, HME communications products, and replacement cartridges. Requests for copy should Specify Catalog No. 123.

- Hycon Company Inc., 11423 Vanowen St., North Hollywood, Calif., in newly-published Bulletin MA, describes the firm's standard-type magnetic amplifiers of toroid construction, and supplies information regarding special designs to suit individual requirements. The bulletin is a single sheet punched for inclusion in loose-leaf files.

- The Stephens Manufacturing Corporation, 8538 Warner Drive, Culver City, Calif., covers the entire line of Stephens Tru-Sonic speakers, enclosures, and accessories in a new catalog of unique design which will be mailed out soon. This new piece of literature is made up of five separate loose-leaf sections placed in a file-size folder which has ends folded to form a retaining pocket. The first three sections are four pages each. They deal with speaker enclosures, coaxial and full-range speakers, and with complete speaker systems. The final two sections are two-page sheets concerned with component speakers, horns, networks, and theater installations.

- Cornell-Dubilier Electric Corporation, South Plainfield, N. J., has prepared a comprehensive twist-prong-type catalog cross-index and price list of recommended C-D replacements for four leading manufacturers. More than 1000 capacitor types are listed. Copies of the publication (form UDX185) are available to the trade without charge.

- General Industrial Company, 5727 N. Elston Ave., Chicago 30, Ill., is distributing a new catalog which should be included in the files of all purchasing personnel in firms which have need for material handling equipment, ladders, storage cabinets, safety ladders, steel trucks, and a multiplicity of other items used in industry. Also incorporated in the catalog are a number of laboratory items such as miniature automatic-control furnaces, wireless intercoms, precision program timers, and "See-Thru" storage cabinets with plastic drawers for storage of resistors, capacitors, and the like. Copy will be mailed on request.

- Triad Transformer Corporation, 4955 Redwood Ave., Venice, Calif., has just released its new General Catalog TR-56 and Television Replacement Guide TV-155. Copies of both new catalogs are available from Triad jobbers or may be obtained by writing direct. Catalog TR-56 lists 495 items, the total of which are to the Triad line. Included among the new listings are a series of sub-miniature audio transformers; several new high-fidelity output transformers; geoformers; and four-disc rectifier transformers for more than $4000 models of television receivers.
EDITOR'S REPORT

THOSE WHO HAVE FOLLOWED the progress of hi-fi over the past five or six years are thoroughly agreed that it is possible to assemble a group of components into a complete system which will provide exceptionally fine reproduction of music in the home. In the last several months, we have noted a growing interest in the so-called "packaged" systems which consist of a number of components usually selected by the dealer or sound specialist and assembled or "packaged" into a complete cabinet—or two cabinets, where the loudspeaker is preferred as a separate unit—and sold as a unit. Obviously, assuming that the assembler's choice of components is good, this is no different than when the consumer buys the same parts and assembles them himself into a cabinet of his choice. As a matter of fact, when the assembly is made by the sound distributor or specialist, the chances are that the work will be done in a more workmanlike fashion, the control shafts will be properly centered in the holes in the panel, the wiring will be shipshape, and so on. But the important thing is that the individual components are each chosen for their own characteristics, and that no compromises are necessary—except possibly for budget limitations—in the choice of equipment. So as long as the "packaged systems" are composed of a number of high-quality components put together in this fashion, we are heartily in favor of them, for not everyone is handy with tools—or even has those that would be necessary—nor is everyone interested in doing the work himself. At least, this type of "packaged" system gives the advantages of a high-quality hi-fi home music system to those who might not otherwise be able to have them.

On the other hand, we have all heard of so-called "hi-fi" systems which are claimed to be at least as good as—or even better than—a properly assembled component system, with money-back guarantees of the claim. Of course, no one who knows his way around in audio believes the claims—not for a minute. However, if the claims are repeated with considerable frequency in places where the uninformed public may continue to see them, it is just possible that they might succeed in convincing the public.

We haven't the slightest quarrel with the idea of "packaged" systems—provided they do sound as good as the assembled component system. And there's the rub. None of them do. No one who takes the time to compare component systems vs. factory-packaged systems is likely to be fooled by the claims. But finding an opportunity to make direct comparisons may be difficult, for those who sell one type rarely sell the other. And the human ear does not have a sufficiently long retentiveness for sound—unless it is especially trained—to make comparisons which are separated by an hour or so if the results of the comparisons are to be valid. One should always insist on an opportunity to make direct, side-by-side listening tests before making a decision. Then and only then can the judgement of the listener be relied upon.

We know, of course, that the manufacturers of audio components do not necessarily have a corner on all the good audio engineers in the country. But we believe that we are justified in saying that if the quality of the engineering personnel may be judged by the quality of the product that the manufacturing organization produces, it appears that there is some sort of corner on the market for audio engineers—and it seems to be with the component manufacturers.

We should not like to define a hi-fi system as one in which the loudspeaker is located in a separate cabinet from the rest of the equipment, for we have heard some excellent systems which were in a single cabinet. These have been exceptions, though, and we have also heard some pretty poor systems in a single cabinet. As a general rule, however, we do not favor a single cabinet for a home music system, and we do feel that it is a compromise when the loudspeaker must be placed in the same housing with the phono equipment. But we will say, without any equivocation whatever, that no assembly of equipment can rightfully be called "high fidelity" if the loudspeaker is housed in an open-backed compartment of a cabinet alter the manner of early radio consoles. And on this point, we imagine that anyone in the audio industry will agree with us.

Comparisons are odious—according to an old saying—but not nearly as odious (odorous?) as some of the claims that have been fed to the public in the name of "hi-fi."
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Improving telephone service for America provides careers for creative men in scientific and technical fields
An Output-Transformerless Amplifier-Speaker System

CURTISS R. SCHAFER

This OTL amplifier requires no critical adjustments. It is used with a high-impedance speaker and a condenser tweeter.

AUDIO AMPLIFIERS without output transformers have been described in several papers within the past few years. As Fletcher and Cooke¹ and Onder² have pointed out, there are several good reasons for eliminating the output transformer. The amplitude, frequency, and phase distortions, as well as inherent copper and core losses, all make this transformer either expensive or undesirable.

Many of the output-transformerless amplifiers, however, have been unsuitable for the home music enthusiast because they either had insufficient power output (les than 10 watts), required a great many tubes in parallel, dissipated enough heat to warp the cabinetry, or permitted excessive direct current to flow through the voice coil (forcing it out of the gap or burning it up) if the output-tube cathode-current balance were not accurately maintained. This article describes the design and construction of an amplifier which (a) will feed a wide-range loudspeaker system directly (that is, without an output transformer), (b) has adequate power output (20 watts at 1.5 per cent modulation, using 60 and 8000 cps), (c) has a wide frequency range (within 1 db) from 9 cps through 30 kc) at both high and low volume levels, (d) incorporates the new extended-range electrostatic tweeters, (e) is in accordance with the results of a great deal of fundamentally sound psychoacoustic research which has recently been published, and (f) is easy to assemble and wire. It is intended to be used as the main power amplifier, fed by a preamplifier or tuner with an output of 1 volt or so. A view of the complete amplifier appears in Fig. 1, while the two-element speaker system is shown in Fig. 2.

The schematic wiring diagram is Fig. 3. The power transformer has been retained for three important reasons: (a) a high plate-voltage supply at low current is required to enable the 5687 stage to furnish adequate signal voltage to the following grids; (b) an electrostatic shield is desirable to reduce noise and hum from the power line; and (c) the regulating action of a filament transformer greatly reduces the initial rush of current into the heaters when the amplifier is turned on, and this action prolongs tube life. (In military and naval electronic equipment, the operation of heaters or filaments in series is forbidden because it results in short and erratic tube life.)

The amplifier input is across a 1-megohm volume control, which may be used as a pre-set. The input stage is followed by a conventional phase splitter. This phase splitter is self-balancing, has low distortion, and has an input impedance of about 10 megohms. These first two stages use a ruggedized tube, the GE 5814A, which is similar to the 12AU7 but has a very low heater-to-cathode leakage, which is important in a phase splitter of this type. A direct current supply is used on the heater of this tube to eliminate hum.

The 5687 is also a rugged, military-type tube which is capable of being operated at relatively high plate voltages without electrolysis of the glass at the base.

The 6337, which was developed in the spring of 1954 by Chatham Electronics Division of the Gera Corp., is the tube that has made this amplifier possible. With a transconductance of 45,000 milliehms, plate dissipation of 80 watts, plate resistance of only 60 ohms, and a hard glass envelope, it is an audio output tube with exceptional power-handling capabilities, rugged internal construction, and a very long life. In conventional transformer-coupled circuits³ it is capable of delivering 7 watts at 3 per cent IM (for one pair of tubes in class-A operation). In this circuit it is operated at only 60 per cent of its maximum plate dissipation, and one-third of the output


power is dissipated in the plate-feed resistors, so the usable power output is about 20 watts. The plate-feed resistors \( R_a \) and \( R_m \) stabilize the load impedance at 167 ohms, despite the increase in impedance at the higher frequencies which characterizes moving-coil loudspeakers. The power transformer \( T_p \) is available as type 1570461 from Electronic Transformer Co. It may also be duplicated by combining other power transformers which the constructor may have on hand. The current ratings of the various windings are as follows: 6.3 volt \( (Y) \), 1 amp.; 6.3 volt \( (Z) \), 14.5 amp., c.t.; 10 volt, 0.4 amp.; 5 volt, 2 amp.; 1000 volt, c.t., 40 ma.

The output of the 10-volt winding is rectified in a full-wave bridge rectifier and filtered for the heater of the 5814A. The value of the 15-ohm series resistance \( R_m \) should be set so that the voltage at the heater terminals of the GL-5814A is 6.0 volts at a power-line voltage of 117.

The low-voltage, high-current plate supply for the output stage uses four 1N158 fused-junction germanium rectifiers in a paralleled half-wave voltage-doubler circuit, providing 250 volts at 800 ma. The 1N158 is a very efficient rectifier, having a drop of only 1.4 volts at full load. The 250 \( \mu F \) capacitors are each made up of two 125 \( \mu F \) units in parallel. A filter choke is used to ensure adequate filtering. (This power supply, incidentally, is almost exactly what is required for the operation of an output stage using two power transistors, such as the Minneapolis-Honeywell type 2N57, as these transistors draw collector currents up to 700 ma each; the only difference is that a regular half-wave rectifier circuit may be used instead of a voltage doubler.) It is a common fallacy to assume that push-pull stages require less filtering in the plate supply. It is true that hum is cancelled out in a well balanced push-pull stage under zero-signal, quiescent conditions; however, the stage is unbalanced the instant a signal comes through, and the hum frequencies react with a signal frequencies to increase the over-all intermodulation distortion, especially at low volume levels.

It should be noticed that one side of the 117-volt power line is grounded in the amplifier. For this reason, a polarized receptacle should be installed where the amplifier will be used, and the cord conducting power to the unit should be fitted with a polarized plug. One side of the 117-volt line is grounded at the distribution transformer, and also where the line goes through the entrance switch; this side of the line will show no voltage, or only a few volts, when an a.c. voltmeter is connected between it and a good ground. This side of the line...
Fig. 4. Three methods of connecting speakers to the amplifier. At (A) a single high-impedance speaker, (B) a woofer and electrostatic speaker, or (C) a woofer and two tweeters.

should be the same as the side that is internally grounded in the amplifier, and in addition, a heavy lead should be run from the binding post on the chassis to a good water pipe or radiator ground.

The power transformer and both choices are mounted with their laminations perpendicular to the chassis; this results in the least amount of magnetic flux being radiated into the chassis. All ground returns must be made to a single point; the arrangement preferred here is a group of six solder lugs tinned under the nut and split lockwasher of one of the screws holding the 15-heavy choke. The use of an aluminum chassis also results in less hum from magnetic flux conduction. The chassis should be finished by being etched, anodized, and then having a coat of enamel baked on at about 35 deg. F. for 3 hours.

Negative Feedback
A great deal of negative feedback is not worthwhile in an audio amplifier. In the first place, practically no increase in speaker damping is achieved when the output impedance of the amplifier is made less than about one-third the impedance of the speaker. This is because the electrical and mechanical impedances of the speaker become the controlling factors.

6 Figs. 12-14 (damping effect of amplifier source impedance on speaker). Audio Engineering, August 1953, p. 27.

In the second place, many professionally designed amplifiers are regenerative at the low and high ends of their frequency ranges. Low-frequency regeneration is obvious because it causes the amplifier to overload with the rumble from a turntable. High frequency regeneration is undesirable because it gives a tinny or "fussy" quality to the highs; this tinny quality is often blamed on the metallic diaphragms used in most tweeters. High-frequency regeneration, as well as low, is caused by phase shifts in the coupling networks in an amplifier, so that the feedback is actually regenerative rather than degenerative, and it has been very much in evidence in a great many recent amplifier designs, as shown by the little ripples which ride the top of a square wave passed through these amplifiers.

In the present amplifier, about 2 percent of the voltage on each output plate is fed back degeneratively to the input of the preceding stage. This is sufficient to stabilize gain and give some reduction in output impedance, and because the feedback is over only two stages, there is no evidence of either high or low-frequency regeneration.

All resistors are 1-watt unless other wattages are specified. The 270 ohm resistors $R_s$ and $R_a$ are required in this circuit because a high-resistance voice coil cannot carry the plate currents for the output tubes. Isolating capacitors are not necessary however, because no direct current can flow through the voice coil even if the plate currents are badly unbalanced. Direct current will flow through the voice coil, however, if the coil is shorted to either the inner or outer pole-piece. For this reason, do not attempt to use a speaker with a rubbing voice coil. If the coil is properly centered, the usual insulation is adequate for the low plate voltage used.

$R_s$ and $R_a$ should be adjusted by means of the sliding taps so that their resistances are approximately equal, that is, within 2 or 3 per cent of each other. This is easily done with an ordinary ohmmeter, not by reading the absolute values of resistance, but by seeing that the deflection of the meter is the same for both resistors.

No critical adjustments of any kind are required on this amplifier. Plate-current balance in the output stage need be only an approximation, (or good low-frequency response does not depend upon balancing out the direct current component in the primary of an output transformer. Balance within 10 per cent may easily be achieved by connecting a d.c. voltmeter between amplifier output terminal $B$ and the voice coil centertap, and then adjusting $R_s$ for a minimum reading on the voltmeter, reducing the voltage range of the meter as the unbalance voltage drops. If a speaker is used that does not have a tapped voice coil, adequate balance may be realized by adjusting $R_a$ so that the voltage drop across $R_s$ is equal to the voltage drop across $R_a$. Once the adjustment of $R_a$ is made it may be forgotten for a year or two, as plate-current drift in the 6337 is negligible.

Loudspeakers
Any one of three speaker arrangements may be used. These are shown in Fig. 4. The one in (A) employs a 12-inch model with a center-tapped 250-ohm voice coil, made up through the courtesy of the manufacturer. At this time, it is not considered it feasible to "make a speaker with an aluminum voice coil having an impedance of 250 ohms. The trouble is that aluminum wire is very fragile, and it is extremely difficult to tin, even by ultrasonic means, as the wire simply disappears during the process of tinning if it is-not-line. It is also not possible to obtain aluminum wire in a "fine" gauge because it is too fragile to handle." The speaker is simply connected across the amplifier output, plate-to-plate, a Wire should be run from the frame of the speaker to the ground binding post on the amplifier chassis.

The frequency response curve of this speaker shows that with the copper voice coil it is deficient at the high frequencies (Fig. 5). One way of compensating for this deficiency is to use about 30 db treble boost in the preamplifier taking care to see that the treble boost complements the treble drop in the speaker so that a fairly flat response is obtained from the combination. The unit should be used in an enclosure that will provide adequate loading at the rear of the cone by means of a folded exponential horn.

The best combination, however, uses

(Continued on page 42)
Experiences In Stereophony

PAUL W. KLIPSCH

Cutting through the nettles of rumor and superstition which surround both merits and techniques of stereophonic tape recording, authoritative Mr. Klipsch gives hard facts, believable impressions of art.

At the parts shows and audio fairs, several demonstrations advertised as "stereophonic" turned out to be two screeching speakers. Told to stand in the middle and toe a certain line with ears 5 ft. \(\frac{3}{4}\) in. above a certain datum, the listener in complying still hears two screeching speakers. One 3-channel demonstration showed plenty of "separation," but gave the impression of three tiny ports in a thick wall. This demonstration used three non-corner speakers in space remote from walls. The same tape heard more recently over three corner speakers in L arrangement gave a better impression.

As a follower of the early art and of stereophony and having talked with the envied few who heard the 1933 show, this writer felt there must be some merit to the art, and a potential of witnessing the effect without putting one's hair in the middle. Stereophony up to 1952 is reviewed by Tinkham who also discusses speakers vs earphones, microphone type, microphone spacing, and other factors. This treatment had been lightly dismissed at first, but success cannot be denied to have come about at least in part by way of this article with its suggestion of wide microphone spacing. After three years there is some disagreement in detail or choice of pressure versus velocity microphones; yet it can hardly be said to diminish the value of either the early or subsequent work.

Recording Equipment

Having an extra Concertone 1502 to play with, we bought an additional amplifier, together with a set of stacked stereo record and playback heads. The two amplifiers were mounted in a separate case. The two bias oscillators were synchronized by the simple expedient of connecting the two erase oscillator outputs to the same erase head. Fear of burning up the head was dispelled when Berlant-Concertone promised a new one if one burned out. Since then a Berlant stereo recorder was obtained; neither machine has given any erase-head trouble. Single-channel recording experience with several microphone types resulted in the choice of the Stephens C-2 microphone with the OD-4 oscillator-discriminator. The output transformer was bypassed. When the recorder was expanded to stereophonic the family jewels were pawned for a second microphone of the same type. The response of these microphones appears to be flat from less than 10 cps up to about 15 kc with an estimated 4-db dip at 16 kc and response beyond that diminishing in a series of wide peaks and narrow dips. Response could be detected out to 37 kc.

Procedure

The first consideration in a successful recording is to get "separation." This seemed to dictate a microphone spacing comparable to the speaker spacing. The first recording attempt was a table tennis game in the plant recreation room at coffee-break time. (Coffee breaks pay off in the most surprising ways.)

The first thing noted was that speakers located in corners against the long wall were better placed than when against the short wall of an oblong room. Thus in Fig. 1 only about a third of the room area is "stereophonic." Outside the "permissible" area either one speaker predominates or they blend with reverberation to conceal the stereo effect. But in Fig. 2, over half the room area becomes stereophonic.

In our case the room is about 30 feet wide, and we found the tennis table to be exaggeratedly long. It seemed, however, that this exaggeration was more tolerable than the absence of the effect. The same thing seems to apply visually on the wide movie screen where we are accustomed to seeing human heads as big as water tanks.

Fear of "lack of separation" prompted the first attempt at music recording to be of an organ and small brass choir. We permitted not only wide microphone separation but also intimacy of each microphone with its subject matter. The result is almost spectacular, yet natural. The sensation is that of the pipe organ in one loft and the choir in another—a sort of antiphonal effect. The speaker spacing in Fig. 2 is preferable. (Incidentally, since Fig. 2 is the speaker spacing considered tolerable in all cases, this remark will not again be repeated.)

A 7-piece dance band in a studio about 25' x 40' was recorded with microphones 15 feet apart. The playback in the same studio was so exciting the band chinned in to form a duet with itself!

Longitudinal Stereophonic

The nearest approach to true stereophonic effect in a two-channel system with-range permutation which may be called lateral stereophonic, or placement of microphones on a line perpendicular to the listening axis. Another very interesting application might be called longitudinal stereophonic. The deep-throated Robert Morton organ at Texarkana's Paramount Theater is in a single pipe loft. A lateral stereophonic did not appear a priori to offer much novelty. Accordingly, one microphone was placed about 20 ft. in front of the swell shades, the other about 80 ft. beyond it. In this manner the organ was recorded, with a microphone in one loft and the other in the other. But the new stereo tapes are beyond words to describe. Attempts to describe by "just adding color to a picture," or "adding a new dimension" are at best pictorial. It is fair to say it adds another level of approach to realism.

In conventional recording, an organ and 48-voice choir were recorded with microphones 15 ft. in front of the front row of singers, approximately 25 to 30...
it in front of the back row, and about 35 ft. apart. It was feared the soloists in the middle would be too far away. The results were far more natural than those resulting from microphones near the soloists and subjected to a mixer in the hands of an engineer. The choral group is as effectively "spaced" as in real life, and the soloists are in natural loudness and geometry as they would be heard in the auditorium. Cutting either channel, by the way, drops the soloist somewhat into the background.

A full orchestra was recorded from the spotlight catwalk, where lack of preparation forced microphone placement at 22 ft. apart, more than 15 ft. in front of and about 15 ft. above the podium. A priori, a wider separation would have been preferred. A posteriori, the separation was adequate but a closer proximity would appear to me desirable. All faults notwithstanding (including a duet between soloist and a ventriloquist on the podium) cutting either channel, by the way, drops the soloist somewhat into the background.

Single-Microphone Stereophonic

An interesting potential is presented in what I choose to call the "poor man's binaural" because it takes only one microphone. The performer, say a pianist, plays one part of a duet; then does earphones and tries to keep in synchronism while he plays the second part. The recordings are separate; the first piano reproduces through one speaker, the other piano through the other. As contrasted with lateral or longitudinal stereo, this might be called "chronolateral" stereo recording. Some neat tricks are involved to keep the two recordings in step on the nonstandard stacked heads, also to help the performer to keep together with the little man that wasn't there. Harlan Thompson of Berlant-Concertone suggested a stuck-head technique involving a playback head preceding erase, a variation of their "sound-on-sound" device and method. For the interested, this is sketched in Fig. 3. Assume the first part of the recording to have already been performed on the top channel on the tape. This is played back and listened to by the performer, who then plays the second part on the bottom channel of the tape. To get the two parts properly stacked, the first recording is erased and re-recorded simultaneously with the second recording. This entertaining recording may or may not become a new and/or important art form. At present it is just a gimmick, but one which is revealing in the matter of musical structure and timing, and the individuals of performers. It is a lot of fun—and hard work for both performer and recordist.

Other Apparatus

It has been said that stereophonic with ordinary equipment has some advantages over single-channel reproduction with fine equipment. This is probably true to some degree, although stereophonic recording of a single solo instrument is marginal, and full range is always to be appreciated. One thing stands out clearly however. One does not need the full bass range on both sides. Naturally, my own personal preference is for a couple of Klipschorn, but one Klipschorn and a second speaker of lesser caliber is highly satisfactory. For a second speaker this writer has used 3-way (and even coaxial) drivers in corner horns ranging from the Cabinet Rebel V up to the Rebel III and Shorthorn 36. The lack of ear directivity for the bass range denies any lack of bass on the "small" channel. But a good trick to follow is to remember to record the "big" instruments on the same side of the tape, and play this side back on the "big" speaker. I designate the top channel as red, the bottom as "green," and when recording a variety of instruments, try to keep the bass on the bottom. It might be suggested as a standard to maintain the bass on the bottom.

Phasing Speakers

Much controversy about phasing of speakers clutters the literature. In 1940, experimenting with a wofer-tweeter combination, it was reasoned that if one could phase the two to be spatially correct, then a 180-deg phase shift of either should make it wrong. A toggle switch became a confusion switch. This experiment has been repeated on many occasions over the years, including application to a certain coaxial which is "phased to 1/4 inch." Always the same result. The phasing at some single point in space may be critical but we have two ears. There has never been a case wherein the phase reversal could be detected by ear. This is true of the stereophonic case.

This does not conflict with the "trinary" stereophonic methods used in World War II, wherein a rotary "slide trombone" varied the phase of received sound. The phase here was varied over a large number of milliseconds delay. The conditions are sufficiently different to be recognized. The simple fact is that speakers need not be phased, nor even be of the same type, and the same is true of the microphones. A copy in my library was made of a tape described as having been recorded with one velocity microphone and one condenser. The only criticism was that of frequency response; the side recorded with the condenser had the "starchy" quality associated with some types of condensers, and the ribbon was a little dull.

Commenting Upon Previous Work

Tinkham² states the microphones must be "placed as far apart as the speakers." It may be that the reproduction will be in a small room with closely spaced speakers; "should we, therefore, reduce the spacing of the mikes? Experiment says no." With this, recent experience is in agreement. Again Tinkham says, "placing speakers in the corners... does not appear to work as well as spacing them in a little way from the corner... a more normal sidewall reflection is set up." With the elementary reasoning, and recent experience (Continued on page 47)

³ There are cases where speakers need to be phased. This is not one of them. One case is where two speakers covering the same frequency range are in close or fairly close proximity. Reversed phasing produces a meridian null which can be well defined.

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Fig. 3. Head, amplifier, earphone, and microphone circuitry for "poor man's binaural" or chronolateral stereophonic recording. Assume the first channel has been recorded on the top and re-recording the top to get it stacked with respect to the second track.

Fig. 4. Philosophy of the corner speaker. (A) symbolizes a non-directional radiator; (B) shows this biassed; (C) shows half the speaker of (A) with the other half a mirror image formed by a wall located at the bisecting line in (B); (D) shows biassing and a corner speaker producing the same radiation pattern in its quadrant as did the non-directional speaker in the same quadrant.
Commercial Acoustic Suspension Speaker

EDGAR M. VILLCHUR

Performance data on the new loudspeaker system in which cone suspension is a carefully controlled volume of air.

In the October 1954 issue of Audio the writer described an experimental speaker system1 in which the bulk of elastic restoring force was supplied by the pneumatic spring of the enclosures’ air rather than by the cone’s mechanical suspensions. The speaker mechanism itself had a subsonic resonant frequency, but when mounted in its acoustically sealed, Fiberglas-filled enclosure the final resonant frequency of the system was raised to a predetermined value of about 45 cps.

The present article is a report on a commercial unit built to the above design. It is considered that there is general interest in performance measurements of a device constructed on a new principle; in addition quantitative data on loudspeaker performance under carefully defined test conditions is relatively rare, and it is hoped that such a report may stimulate the publication of similar reports on other speakers.

The commercial unit is made as a two-way system using a 12-inch acoustic suspension woofer in combination with a conventional cone-type high-frequency speaker, and is also made as a woofer system for use with other high-frequency units. The system is illustrated in Fig. 1. It was decided to report on the model with the woofer alone for the following reasons: (1) The point of the article is to make a quantitative report on the capabilities of the acoustic suspension system, and (2) test procedures are simplified and made more reliable, thus better subject to accurate duplication by others. Variables such as radiation angle, microphone calibration at higher frequencies, and interference effects between the two speakers which may make microphone positioning critical, are largely eliminated. The performance of the high-frequency portion will be only briefly summarized.

The two basic criteria of measurement techniques are validity and reliability. Validity refers to the degree to which the tests measure what they are supposed to measure, and are uninfluenced by other factors. Reliability refers to the accuracy of the measurements; it is an index of the extent to which the measurements can be duplicated at other times and places.

Reliability

A valuable paper on loudspeaker frequency response measurements2 has pointed out the dangers involved in interpreting speaker frequency response curves when the exact test conditions are not known. Three such curves, made by three different acoustic laboratories using the identical speaker, were compared with each other and shown to differ by as much as 10 db at different portions of the frequency spectrum.

In the present case it was decided that unless test conditions could be established that would make it possible for results to be readily duplicated by anyone with the necessary facilities and skill, the measured data, while it might have a limited usefulness, would be unsuitable for publication. The frequency response and distortion measurements published here have been duplicated without significant variation. It is believed that any tests conducted under the same controlled conditions will achieve results which are within 1 db of the frequency response curve and will add or subtract less than one per cent to the values of the distortion curve.

Conditions Of Test

The enclosure was placed in a hole in the middle of a 2-acre field, its face flush with the surface of the ground (see Fig. 2). The speaker was fed from an amplifier with a controllable source impedance, and a microphone was suspended at a distance of 5 feet above the enclosure, on axis with the cone. This means that the speaker was radiating into a controlled 180-deg. solid angle, into essentially free space, driven by an amplifier with a controllable damping factor.

The reliability gained by such test conditions involves a certain sacrifice in validity if what we are measuring is musical fidelity. One does not listen to a loudspeaker when one is suspended from a boom in the middle of a field, and in addition the effect of refraction from the cabinet edges, which would be present under any conditions except a bookshelf installation, is not taken into account.

The alternatives, however, are worse. If we test the speaker in a normally live listening room we will get a different frequency response curve for each microphone position and for each room we use, and interpretation becomes difficult. Room resonances may accentuate or suppress various harmonic distortion products. Similarly, diffraction from the cabinet edges will create interference effects that will change the response curve with even small changes of microphone position. Thus RETMA Standard SE-103, in describing methods of measuring speaker pressure-frequency response, states that if there are no manufacturer specifications on mounting for a direct-radiator speaker:


Fig. 1. Acoustic Research AR-1W low-frequency speaker system. The two-way system uses the same cabinet.

1 Acoustic Research, Inc., 23 Mt. Auburn St., Cambridge 88, Mass.
represents musical fidelity under normal listening conditions. We know, for example, that the perception of relative bass content in reproduced program material varies with the volume level of the sound, a phenomenon called the Fletcher-Munson effect. Room acoustics, speakers, placement, and other listening conditions can strongly influence the actual perception of sound in the final listening.

Validation must then be made by correlating objective data with subjective judgments, and by deductions that cannot, by their nature, be as rigorously tested as casual. It is universally accepted, however, that the avoidance of dips and peaks in the response curve (ignoring slope) is a good thing. The writer then suggests that, considering the sensitivity of control that can be exerted over electronic as opposed to mechanical devices at the present state of the art, any equalization be assigned to amplifier circuitry. This leaves us with a response curve for the 180 deg. solid angle which, if flat.

Fig. 3. Harmonic distortion-frequency characteristic of the AR-1W, under conditions noted.

will be transformed into a response that includes boost of the low bass when the speaker is mounted in a corner or at the junction of the floor and the wall. In the case of the unit tested the effective amplifier source impedance can be changed externally by switching from the 8-ohm to the 4-ohm connection, providing flexibility of bass response for different mounting positions. A test run was made with the speaker placed in the corner of a normal listening room, the driving source impedance being low—that is, using an amplifier with a relatively high damping factor. The results of this test are indicative of general performance under such conditions but not as rigorous as the free field tests. Optimum use of the acoustic suspension system, as of any other speaker, is considered to be with an amplifier that has a variable damping factor, which is adjusted to optimum (not maximum) bass response under the conditions of operation. It is agreed among acoustics authorities that there is an optimum source impedance from which to drive a given speaker mounted in a given way for the most uniform and extended bass, but this...

3 This applies to the woofer; the problem is complicated in the case of the high-frequency speaker by the differences between on-axis and off-axis response.

Fig. 4. Harmonic distortion of the AR-1W in the corner of a room.

It should be noted that the main factors which determine the final resonant frequency are the mass of the moving system, the cubic volume of the cabinet, and the amount of Fiberglas filling, all of which are readily subject to accurate control. The elastic stiffness of the suspensions, a factor which is not so easily controlled with accuracy, contributes only about 10 per cent of the total elastic stiffness, and the resonant frequencies of different products may vary, and therefore be kept within small tolerances.

Harmonic Distortion

Distortion data is listed before frequency response data in order to validate the former. We are not interested in the total amount of sound put out by the speaker when stimulated at particular frequencies, including spurious harmonics, noise, etc., but in the output of reasonably undistorted sound at different input frequencies. A frequency response rating that extends down to 32 cps has little significance if the harmonic distortion at this frequency is 40 per

Fig. 5. Oscillograms of acoustic output of AR-1W (conditions listed in Fig. 4) at 10 watts to rated impedance, at 32, 60, and 100 cps, respectively, from left to right. The extreme uniformity of output is accidental, as can be seen from the frequency-response graph of Fig. 7.

Quick Capsule

Harmonic distortion of the AR-1W was determined by the procedure outlined in previous articles. A brief listing of characteristics of the unit tested appears below:

Model No. AR-1W
Magnetic circuit 33 lbs. Alnico 5
Frame 6 lbs. Armco iron
Nominal diameter 12 inches
Resonant frequency Subsonic level
Final resonant frequency of system 43 cps ± 1 cps
Cabinet Ribbed 3/4 in. stock, dimensions 25 × 11¾ × 14 in., acoustically sealed and filled with Fiberglas.

It is important to note that the materials vary in stiffness, and the resonant frequencies of different products may vary, and therefore be kept within small tolerances.
cent at moderate power, other than to indicate that the designer has attempted to extend the bass response further than he should have for that particular speaker. Attenuated output is by far preferable to distorted output. Similarly, a low distortion reading at 32 cps has little positive significance if speaker response is down 20 db at that point. The distortion graph of Fig. 3 should be read in conjunction with the frequency-response graph of Fig. 6, so that the distortion curve refers to the reproduced frequency range, and the frequency-response curve refers to the range of low-distortion reproduction. The necessity for validation of the frequency-response curve by distortion data is clearly indicated in ASA Standard C16.4-1942, which in listing essential practices for plotting pressure-frequency response characteristics states:

"Unless otherwise stated, the values of pressure plotted shall be those corresponding to the fundamental frequencies." (Italics supplied.)

The graphs of Fig. 3 plot the r.m.s distortion-frequency characteristic of the AR-1W at 10 and 20 watts input to the rated impedance (4 ohms). Amplifier gain was adjusted to 6.3 and a voltage output across the speaker at 175 cps, and left that way for the run. The radiation angle was 180 deg. Figure 4 plots the distortion-frequency characteristic of the AR-1W in the corner of a normally live living room, and Fig. 5 shows oscillograms of the acoustic output of the speaker at 32, 60, and 100 cps, with 10 watts into the rated impedance under the latter conditions.

A word of caution about the interpretation of the distortion figures must be inserted at this point. The reference power levels are electrical, and the inefficiency of the speaker (referring to the electrical power required for a given acoustical power) therefore favors the readings. The sound level is also quoted, but will be meaningless to many readers. The only correct way to compare the data with corresponding data from another speaker would be at the same sound pressure level at a given frequency, not at the same electrical power input. The range of difference in commercial speaker efficiencies is probably at least 25 to 1.

The efficiency of the AR-1W, on the other hand, is close in value to that of several other commercial units for which the writer has a high regard. It should also be noted that the efficiency of the AR-1W remains essentially constant down to very low frequencies (see Fig. 5), and the absolute efficiency in the 30-60-cps octave may be greater than that of another speaker with a much higher over-all efficiency rating. For example, if pressure response at 40 cps is down 9 db (which still allows for an excellent low-frequency reproducer) the efficiency at that frequency is reduced by a factor of 8, and it will require 8 times the amplifier power to create the same sound pressure level as at the reference level. The AR-1W used as an organ pedal tone generator could not be considered an inefficient speaker. When the latter is used for 180 deg. radiation conditions (mid-wall shelf mounting) the efficiency is halved. The conditions of the 8-ohm connection can be achieved without such loss of speaker efficiency by using an amplifier with a damping factor of 1.

**Frequency Response**

The graph of Fig. 6 plots the frequency response of the AR-1W under conditions described above. The ratio of horizontal-to-vertical scale follows RETMA Standard SE-103, which states:

"The length of a 10 to 1 frequency interval shall be the length of 30 db on the ordinate scale."

The graph of Fig. 7 plots the frequency response of the speaker in the corner of a normally live living room, fed by an amplifier with a damping factor of 4.

**Transient Response**

Good transient response is associated with a uniform steady-state frequency-response curve. The transient response of the AR-1W can be predicted from the frequency-pressure curve of Fig. 6.

The bass transient response was also checked visually with square waves and an oscilloscope. Figure 8 illustrates the response of various speakers to a square wave of subsonic fundamental frequency. In (A) the cone of an ideal speaker moves forward to the top of the square wave and remains completely motionless over the horizontal portion, while air pressure at the microphone decays smoothly. There is no hangover whatsoever. A poorly damped system is represented by the acoustic output in (B), which exhibits definite ringing after the initial stimulus. (C) is the acoustic output of the AR-1W speaker system as recorded with microphone and oscilloscope, showing slight overshoot.

**Efficiency**

Efficiency has no direct relation to quality, but it does have an indirect one in that the power demanded from the amplifier by an inefficient speaker may exceed the amplifier rating. If the available voltage driving the amplifier is great enough the amplifier may then overload and distort. It is also true that in A-B tests the lower system tends to sound better automatically, and an efficient speaker has the edge in audio salesrooms if the electrical levels are not adjusted for equal volume from each speaker.

Interpreted in general terms the sound pressure levels indicated in Fig. 6 mean that a good 10-watt amplifier is adequate for the AR-1W or AR-1 speaker for moderate listening levels in typical living rooms. For larger rooms and for those who like very high levels of reproduced sound, at least 30 clean watts are required. The RETMA efficiency rating of the AR-1W at 100 cps is 21.5 db.

In constructing a figure of merit for a loudspeaker system designed for home reproduction the question would arise as to what place, if any, efficiency would receive. If manufacturers were canvassed as to the significant factors in such a figure of merit (Continued on page 33)
Adapting A Record Changer To Hi-Fi

ADOLPHE F. STERKEN

Some alterations improve performance of a standard changer.

In any Hi-Fi music system it is extremely desirable to hold record and stylus wear to the minimum, and also to hold the noise level down as far as the budget will permit. Both of these objectives may be attained through the use of professional turntables and pickup arms, but then we run headlong into the budget problem as well as the inconvenience of sacrificing the automatic feature of the record changer. There is, however, a solution to this problem which is quite inexpensive, and is relatively easy for any hobbyist having a record changer and a few elementary hand tools.

The problem of turntable rumble was solved by the addition of a heavy steel turntable supported by foam rubber cushions on top of the existing changer turntable. As this auxiliary turntable fits freely over the spindle of the changer, records can still be stacked and played automatically as before, a desirable feature where the system is also used as a source of background music. The reduction of record and stylus wear is accomplished by constructing an auxiliary pickup arm having the greater length, reduced tracking error, and friction-free pivots found only on transcription-type arms. As the end of this home-built arm was cut from a plug-in head replacement arm for the record changer, the cartridges are interchangeable between the new arm and the record-changer arm.

The Auxiliary Turntable

The auxiliary turntable which was used (Fig. 1) is a 12-inch-diameter heavy steel disc removed from an old acoustical phonograph. The only alteration required was sawing off the center bearing to a depth of about one-half inch. This heavy disc was chosen for its large mass and inertia which produces the desirable flywheel action. Earlier experimentation indicated that insufficient mass above the cushions permitted objectionable oscillatory vibration of the record if the cabinet was jarred. It was also found that grounding the upper turntable to the lower one with flexible wire substantially reduced hum-pickup from the changer motor.

The auxiliary turntable was attached by liquid adhesive to the four foam rubber cushions which support it. These cushions absorb vibration from the driving mechanism and permit the application of a more uniform torque to the upper turntable. Each cushion consists of a one-half-inch-thick foam rubber disc 1 3/4 in. in diameter which is cemented to a like-diameter sheet-steel disc. The details appear in Fig. 2. A threaded nut is soldered onto the side of this disc over a center hole. These cushions were fastened to the record changer turntable by machine screws through holes in the turntable which were drilled oversize to permit lateral adjustment of the cushions in centering the upper turntable. After the cushions were installed, adhesive was applied to the top of each cushion and to the underside of the auxiliary turntable. The turntable was then lowered into place over the spindle, taking as much care as possible to have it centered when the adhesive coated surfaces come in contact. As the center bearing made higher cushions necessary, cardboard discs were built up on the top of each cushion.

A further improvement can be accomplished by inserting a special stub spindle which is interchangeable with the original after its retaining clip has been permanently removed. This special spindle is a short one made to fit into the top turntable only, thereby mechanically isolating the record from the drive mechanism. Also, it is made oversize to fit tightly into the record center hole for better centering of the record, which materially reduces wow. Using this spindle does necessitate manual changing of the record, however.

The Auxiliary Pickup Arm

Since the record changer's mounting springs permit relative motion between the changer and the mounting board, the arm could not be mounted on the board as a separate unit, but had to be free to move with the changer. This requirement accounts for the heavy outboard flanged plate mounting bracket which is bolted to the edge of the changer base (at left in Fig. 3). This black steel plate, about 3/32 in. thick, was bent on a brake in the sheet-metal shop. Lighter-gauge galvanized sheet steel was selected for the rest of the hinge assembly (detailed in Fig. 4) so that no tools other than two pairs of pliers would be needed to form the pieces. The bearings for both horizontal and vertical

(Continued on page 45)

Fig. 2. Detail of the foam rubber pad assemblies. A nut is soldered to the inner side of the steel disc and paper poker chips add height.

Fig. 3. The new arm is mounted on an outboard flanged plate to accommodate the increased length.

Fig. 1. The new turntable assembly (shown upside-down for better visibility) consists of a heavy steel turntable from an old acoustical machine connected by foam rubber to the changer table.

* 540 S. Crest Road, Chattanooga, Tenn.

Audio • July, 1955
Point-Contact Transistor Amplifiers¹

RICHARD F. SCHWARTZ²

A note on the use of push-pull connections in transistor circuitry.

The problem of obtaining higher power with less distortion exists in transistor circuitry just as it does with vacuum tubes. Although vacuum-tube practice suggests several obvious ways of reducing distortion, there are several techniques peculiar to transistor circuits alone. The work described here was done in the early days of transistor development, so that no reference is made to current manufacturers’ type numbers.

The Single-Ended Circuit

Figure 1 shows a typical grounded-base transistor audio amplifier, transformer-coupled to source and load. For small signals the distortion is negligible, but as the transistor is driven harder, the output grows larger and begins to show considerable distortion. This arises from the fact that the emitter-to-base path is a nonlinear circuit like a crystal diode. Larger driving voltages cause larger excursions over the nonlinear characteristic causing the resultant current to be distorted. Since in a transistor the output current is proportional to the input current and ideally has the same waveform, a distorted input current produces a distorted output current. To prevent the input current from being distorted, we must prevent the dynamic emitter resistance change from being large, percentage-wise. This can be done by placing a resistor $R_s$ in series with the emitter, as shown in Fig. 2, so that the changes in emitter resistance are smaller with respect to the total input resistance. Of course, when this is done, the total voltage necessary to drive the transistor circuit must be increased, driving power is wasted in the resistor $R_s$, and the efficiency of the circuit is less. However, a good compromise can usually be reached between driving signal available and desired performance.

Another way of looking at the above phenomenon is to say that the transistor is a device requiring a constant-current driving source (such as another transistor or a pentode vacuum tube).

Placing the linearizing resistor as in Fig. 2 has one drawback: it is in the d.c. path as well as the a.c. path. Hence, it may necessitate a change of the d.c. bias to maintain the same operating point. This can be circumvented by either placing $R_s$ in series with $R_1$ and $R_2$, or by placing a correcting resistor $R_t$ in series with the d.c. source and emitter resistance change from being large, percentage-wise.

This technique is well known, having been used for obtaining linearity in diode detectors. See for example: Edmund A. Laport, “Linear rectifier design,” RCA Review, July 1938, pp. 121-124.

The Push-Pull Circuit

For more power and less distortion in vacuum-tube circuits, use is made of the push-pull connection. The same would be expected of transistors. However, before the advent of satisfactory quality control in transistor manufacture, such a circuit would give more power with quite unpredictable results in regard to distortion. Only by careful selection of matched units could distortion be reduced in the ordinary push-pull connection. Even with present-day units, best results can only be obtained by selection.

The ideas set forth in the discussion of the single-ended circuit apply equally well to the push-pull case. That is to say, the amplifier prefers to work from a high-impedance driving source. Figure 3(A) shows how this would be applied for two reasonably well matched units. If the units are not well matched then Fig. 3(B) is more useful since it allows changes to be made in each half of the circuit individually. It is to be noted that this latter circuit only is capable of adjusting each transistor for best performance and cancels no distortion.

A different circuit, in which distortion arising from the use of unmatched units is cancelled, is shown in Fig. 4. Here the same busing is used for both transistors and a common correcting resistor $R_t$ is applied in such a way as to compensate for the inherent differences in characteristics. The operation of the circuit may be explained by referring to Fig. 5. This represents the equivalent circuit of the a.c. emitter section of the push-pull amplifier of Fig. 4. The generator $E_o$ represents the distortion voltage produced.

Table 1

<table>
<thead>
<tr>
<th>Resistor $R_s$ (ohms)</th>
<th>E$_m$ (rms volts)</th>
<th>E$_m$ (rms volts)</th>
<th>Driver Power (total mw)</th>
<th>Overall Distortion (rms volts)</th>
<th>Overall Power Cons. (mw)</th>
<th>Power Output (rms volts)</th>
<th>Collector Efficiency</th>
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<tr>
<td>0</td>
<td>.15</td>
<td>.15</td>
<td>.218</td>
<td>15.8</td>
<td>11.66</td>
<td>3.2</td>
<td>2.5</td>
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<tr>
<td>210</td>
<td>.44</td>
<td>.15</td>
<td>.607</td>
<td>62</td>
<td>7.22</td>
<td>3.2</td>
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<tr>
<td>500</td>
<td>.75</td>
<td>.15</td>
<td>1.012</td>
<td>84</td>
<td>9.00</td>
<td>3.1</td>
<td>2.5</td>
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<tr>
<td>100</td>
<td>.25</td>
<td>.25</td>
<td>.545</td>
<td>28.0</td>
<td>11.21</td>
<td>3.2</td>
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<tr>
<td>210</td>
<td>.69</td>
<td>.25</td>
<td>1.447</td>
<td>11.4</td>
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<td>7.2</td>
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<tr>
<td>500</td>
<td>1.24</td>
<td>.25</td>
<td>2.455</td>
<td>7.45</td>
<td>4.67</td>
<td>7.2</td>
<td>5.62</td>
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</tbody>
</table>

Values of power input for $R_s = 0$ were computed. Other values were measured.

Fig. 1 (left). The grounded-base transistor audio amplifier. Fig. 2 (right). The resistor $R_s$ in series with the emitter has a linearizing effect.

¹ Moore School of Electrical Engineering, University of Pennsylvania.
² Work done while with RCA Victor Division, Camden, N. J.
³ Patent applied for.
by one emitter circuit, but not the other. This voltage will cause a current $I_b$ to flow through resistor $R_0$ producing a voltage drop. This voltage drop is applied to the emitter of the second transistor at $180^\circ$ C. from the original distortion voltage $E_0$. Each distortion produced by each transistor emitter circuit, therefore, injects an opposing distortion in the other transistor. In addition, there is a similar action taking place in the fundamental components of the emitter currents, tending to equalize them. Because of the fact that the resistance needed to cancel one harmonic term completely is not the same as the value needed to cancel another, an optimum value of $R_0$ with respect to overall distortion or with respect to any given distortion term exists. Experimentally, this was found to be of the order of 100 to 200 ohms for all the transistors investigated. This value is, of course, very much smaller than the value of the biasing resistor $R_0$ of Fig. 4.

The use of balancing resistors in push-pull vacuum tube amplifiers is well established; for example, the common cathode resistor for balancing plate currents, and the common grid resistor for balancing high audio-frequency grid voltages. However, in both these examples, a different action takes place from that which occurs in the push-pull transistor circuit. In the case of the transistor, a.c. emitter current flows at all times and thus produces the correcting action. The correction takes place at all frequencies. Furthermore, the correction resistor has a linearizing effect on the emitter circuit. There is no degradation produced by this resistor comparable to the degeneration effect in a common-cathode-resistance push-pull vacuum-tube amplifier. Nor is the circuit action the same as the second example cited, for in the push-pull vacuum-tube amplifier grid current does not flow continuously.

Table II shows a typical set of data on the performance of the circuit of Fig. 4. The dissimilarity between the two transistors is clearly shown by the unbalance in a.c. emitter voltages ($E_{e1}/E_{e2}$) and d.c. emitter and collector currents. However, the a.c. collector voltages are not too dissimilar. The introduction of $R_0$ decreases the dissimilarity.

Other dissimilar transistors were tried in this circuit with comparable results. It can be seen in Table II that for an output of 7.2 mw the over-all r.m.s. distortion was reduced from 27 per cent to 2 per cent. For this improvement, the driving voltage had to be increased by a factor of nearly 2. Comparing this to the data in Table I, it is seen that the distortion improvement in the push-pull circuit does not require as much increase in excitation as does the single ended circuit. The collector power efficiency is low and of the same order as in the single-ended class A amplifier. It is changed only slightly by the addition of the compensating resistor $R_0$.

### Table II

<table>
<thead>
<tr>
<th>Performance Data for Push-Pull Amplifier of Figure 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.C. Emitter Currents</strong></td>
</tr>
<tr>
<td>$I_e$ (ma)</td>
</tr>
<tr>
<td>0.100</td>
</tr>
<tr>
<td>800</td>
</tr>
<tr>
<td>105</td>
</tr>
<tr>
<td>800</td>
</tr>
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</table>

Fig. 3. Push-pull audio amplifiers. At left is a circuit with a single linearizing resistor while the diagram at the right illustrates the circuit having separate resistors for the two transistors.

Fig. 4 (left). A low-distortion push-pull amplifier. Fig. 5 (right). Equivalent circuit for the amplifier of Fig. 4.
Sound Engineer At Work

W. H. JOHNSON

Sound-system specification and layout is not so simple as it may seem to some. This article shows how experience, thought, and good equipment can be combined to create a system which brings sound to the paying customers instead of broadcasting it over the countryside to unwilling or unauthorized ears.

Misconceptions about sound are among the most prevalent misfortunes of the audio industry today. To the average person a sound system is just a means by which a sound or noise (and often more noise than sound) is amplified to a point loud enough to hear, without thought of quality of either equipment or results. It is assumed that the sound engineer merely looks into his crystal ball and utters a few words of magic (or porfaniety) and out comes a Handy Dandy Little Six power amplifier complete with speakers and microphones, leaving only the artist or announcer to be procured. This school of thought brings about the belief that the sound engineer can supply a sound system for $200 or $300 that will correct all architectural acoustical defects, the effects of wind and rain, and any other condition that may exist short of fallen arches or ingrown toenails.

However when the sound engineer is given the opportunity of designing and building a proper system for a specific purpose the end result is a happy engineer and a still happier customer.

Such were the problems of sound as presented to Altec Lansing sound contractor Satterfield Electronics of Madison, Wis., and to their Chief Engineer, S. N. (Sid) Vinge. Sid was contacted by Richard Knoff, Chief Electrician of the University of Wisconsin; and after consultation with the Athletic Department and other University of Wisconsin officials, he was commissioned to produce sound for the Stadium (Fig. 1), Field House, and the new Athletic Department Practice Building.

Work was started, and at the eleventh hour it became necessary to have the system in operation for the 1954 Home-coming Game. Sid placed his orders for components, horns, speakers, amplifiers, and consoles, with the instructions that the material be flown by air to the site. At 9 o'clock on Thursday morning a large cargo liner touched its wheels on the Madison Airport, and three days later on Saturday at noon the system was completely installed and ready for the football game at 2 in the afternoon.

Sid and his staff were not idle while waiting for the material to arrive, but were hard at work laying cable, laying out circuit and working drawings; and Mr. Knoff of the University started the design and construction of the frames for the stadium speakers and the project-er for the field house. So completely was this project planned that not one moment was lost—for by no other means could this complete system have been assembled and installed in the less than three days that were allotted.

The operation of the system is very simple, yet so well conceived and designed that every possible function desired of it can be properly handled. The operational base of the system is the control console in Fig. 2, composed of an Altec 1560A console with three Altec 1510A preamplifiers. This presents six 30/50-ohm low-impedance microphone inputs, each input having an associated gain control with an “on-off” key for each microphone line. The console also contains provisions for input of two 600-ohm lines, each having its associated gain control and key switch. These positions are such that the console can feed two program or telephone lines or receive the feed from two 600-ohm lines, according to the requirements of a par-

* 809 Monroe Street, Racine, Wis.
Figs. 2 and 3. This control console is the brain center of the installation. 

Fig. 5. Twelve of these horn-loaded speakers are around the Stadium. Mounted almost at ground level and directed slightly upward, they project sound toward the listeners who are located on the rising tiers and thence into space rather than into the town.

Fig. 3. The projectalier is hung on cables and can be raised and lowered by a winch.

Fig. 4. The projectalier of Fig. 3 looks like this when hoisted into operating position.

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pecific event or activity. Cue facilities are included and both aural and visual monitoring provisions were made.

Because of the varied activities held in a university Field House and Stadium the speakers are divided into four groups — those serving the north, south, east, and west ends of each building. Each speaker group has an associated 70-watt Altec Lansing 1530A power amplifier. The amplifiers are mounted in two enclosed cabinets located in the Field House at the south end of the stadium. By means of patch cords the Stadium speaker lines, the Field House speaker lines, and the Practice Building speaker lines are connected to the amplifier associated with each speaker group. Also in the recessed patch-cord panel are a group of switches which permit the instantaneous connection of any speaker group to another power amplifier should a tube failure occur during operation of the system. Also included in the section is a voltmeter to read the peak voltages on any speaker line and to read the condition of both the line and the amplifier.

Microphones used are Altec 660 dynamics. They are located in the press box in both the Stadium and the Field House, and field function microphones — for between-the-half ceremonies — may be plugged into buried receptacles on the 50-yard line. In the Field House microphones can be connected to locations on the floor and elsewhere in the building when necessity dictates.

In addition to the building of the twelve frames for the field speakers (each consisting of an Altec H1003 multichannel horn and 290C compression driver with 70-volt line transformer) there was the problem of mounting the speakers in the Field House. These speakers are also Altec units; the projectalier of Fig. 3 contains four 803A 15-in., heavy-duty, cone-type loudspeakers in 612 cabinets and four H1803 multichannel horns complete with 290C drivers and four N500C networks. The finished projectalier weighed just over 1800 pounds and is supported by stainless steel cables (3-ton capacity) on an electric winch to raise and lower the complete assembly.

As one picture equals a thousand words the photographs accompanying this article will show more at a glance than this writer could set forth in several pages. These photographs show an example of a properly engineered sound system. Other systems had been used, but with sad effects. Speakers mounted on the field house and projecting over the stadium told the city of Madison what was happening at the game while the paying customers heard little. When speakers were mounted at the opposite end the sound was reflected from the Field House wall in such complex waves that again the sound was unintelligible. But application of sound engineering principles by Sid Vinje in placing four speakers on each side and two at each end, and facing them into the crowd, has brought the projection of sound to where everyone present can hear and understand what is said. The townsfolk who cannot listen to the games by radio from long projection paths of the early days have misplaced speakers. Sound is an art and when applied a system such as this at the University of Wisconsin is the
LONDON LETTER
(from page 7)

Leak and the Acoustical electrostatic speakers are referred to the articles which have been appearing by their respective inventors in British journals. The Leak equipment has been dealt with in the May issue of The Gramophone and P. J. Walker has written three articles about his speaker which have appeared in the May, June, and July issues of Wireless World.

H.M.V. Stereasonic Tapes at 7 1/2 ips

The B.S.R.A. Show enabled a further hearing to be made of the H.M.V. stereasonic tapes, and for the first time, H.M.V. gave a demonstration solely at 7 1/2 ips on what is claimed to be the equipment which will be marketed in the Autumn. It is believed that the two cabinets with 10-watt amplifiers, one fitted with a record changer and the other with a dual track tape deck will cost about $1000.

It was possible to hear only part of the demonstration and the excerpt from "The Marriages of Figaro" was again very convincing. On the other hand, your correspondent feels that until one knows the price of the tapes, it is very difficult to pass an opinion as to whether or not all this is worth while. The equipment will cost almost double the price of a single channel unit. It may well be that the tapes will cost three or four times the amount of comparable performances on recordings and until this information is available, it is difficult to forecast whether many Audio enthusiasts will be prepared to embark in such an installation in their homes. Nevertheless, H.M.V. are to be congratulated on their new policy of being progressive which, unfortunately, they have lacked for so many years since the War.

Immediately after leaving the H.M.V. demonstration we listened to the Leak one mentioned above. Without hearing one demonstration side by side with the other, it is difficult to pass an entirely considered opinion, but many visitors to the Show thought that an orchestra on the Leak electrostatic-moving coil combination sounded no less like an orchestra than when heard stereoscopically on the H.M.V. equipment. Furthermore, H.M.V. had the advantage with the orchestra being on tape whereas Leak had to reproduce from ordinary commercial records which theoretically, have much more distortion than a tape which is being made direct from a master tape.

Knocking Loudspeakers with a Hammer

During the B.S.R.A. Show, Gilbert Briggs again filled the Royal Festival Hall with an enthusiastic audience to listen to his second London lecture-demonstration of live and recorded music. These affairs have now created such interest that even the staid newspaper, The Times which rarely refers to commercial activities, devoted nearly half a column to Mr. Briggs' latest venture. Many visitors thought that the demonstration was much better than the one held some months ago, for a chairman was dispensable with and there was less talk and more sound. Nevertheless, one could not have too many comments by Gilbert Briggs for he has a flair for giving a lecture of this kind and possesses a remarkable wit and ease of delivery. The comparisons on this occasion were even more interesting because they included live and recorded performances of the harpsichord, piano, Great Festival Organ and a choir of 30 voices.

Changes were made either way. In some cases the recordings were heard first and in other cases, the artists. He is probably the only lecturer in the World who has commenced his lecture by hitting the beautiful cabinets of the loudspeakers with a hammer in order to demonstrate the difference in resonance between those which were lined with tiles and those with sand.

The demonstration started with an Audio-iphone record, "Memories of You" AP-7 being played on two 8-in. Wharfedale Speakers in RJ cabinets. Briggs makes these RJ cabinets in England under licence from America. The other loudspeakers on the platform were assemblies of his 15-in. speaker with two or three treble units. Four of these assemblies were available and were used together or separately according to the type of recordings being reproduced.

One tremendous advantage possessed by Briggs is the co-operation of P. J. Walker, who is responsible for operating the records and controls of his Quad amplifiers. Walker seems to be able to estimate better than anyone else the correct setting of a gain control for the reproduction of records. The reproduction of the Nixa record of a piano duet of "Variations in B Flat" by Schubert was, your correspondent thought, more realistic than a stereoscopic tape of piano music heard at the H.M.V. demonstration, largely because the piano in the Festival Hall was not reproduced too loud whereas the H.M.V. reproduction just did not sound like a piano.

Tuning-up Records

Audio enthusiasts were interested in the method of showing the number of watts used. A system of indicators were mounted in the centre of the stage and showed instantaneously the watts being fed to the speakers at any appropriate moment. In some cases, when a direct comparison was being effected between the live and recorded performances, Briggs had recorded tuning up notes on the records so that Walker could adjust the Garrard variable speed transcription motor to ensure that the pitch of the record was identical with that of the instrument on the stage. As Briggs said, it was common for orchestras and artists to tune up in a Concert Hall and he therefore did not see why a record also should not be tuned.

Possibly the greatest tribute to Briggs' lecture was that during some of the recordings there seemed to be considerably less coughing and background noise from the 5,000 visitors than is usually the case when a live orchestra is playing in the Hall. So as to reduce scratch, some of the Record Companies had co-operated by supplying metal positives of the records used. Special recordings of the choir had been made by E.M.I. on tape at 30 ips. At the conclusion of the demonstration, Mr. Briggs revealed that in the Autumn he hopes to stage a similar demonstration in New York.

He must be getting publicity minded, for whereas in the first Festival Hall Show, the name Wharfedale was not mentioned at all, neither did his trade mark appear on the stage, at this demonstration he did mention once the name of his loudspeakers. As all seats for these demonstrations in England have been sold out within a day or so of the announcement of the dates and more than 500 people on each occasion immediately bought all the standing room, American Audio enthusiasts would be wise to make early application for their reservations for the New York Demonstration which is scheduled for Town Hall on Sunday, Oct. 9, at 3:00 p.m.

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The first high-fidelity FM receiver was constructed for Major Armstrong in 1936 by a trio whose two surviving members are now the president and vice president of Radio Engineering Laboratories. The first model looked more like a "ham" transmitter than a radio receiver, but the present model retains little of the appearance of its predecessors. However, the performance and stability are still there—to an even greater degree.

As shown in Fig. 1, the Precedent is as sleek and aristocratic looking as one might wish. The dial, tuning meters, and the name are softly lighted, the styling is functional, and the dial is calibrated with laboratory accuracy. The two meters are easily read, with one showing the exact center of the received signal, and the other indicating the signal strength of the received signal. The large knob controls the tuning, while the others control r.f. and audio volume.

The tuner is constructed in an unusual form, called by the manufacturer the "Thermonicube." It consists of three chassis mounted vertically, in effect, with r.f., i.f., and audio tubes projecting into an "air shaft" which extends from top to bottom through the receiver. When the unit is removed from its protective cage, practically every component is exposed—the exceptions being those in the r.f. tuning section, which has a separate bottom plate. At the right is the r.f.-i.f. section; the limiters and the audio section are at the back; and the power supply section is at the left. The protective cover is held in place by two Cam-Lock fasteners. The rectangular frame around the panel simply snaps into place. The holes for the screws may be removed instantly to replace dial knobs or to reach the mounting screws.

All connections are made to the rear of the unit. The power leads are attached to the cover, and engage the input receptacle only when the cover is in place. High and low impedance outputs are available—one at an impedance of some 3000 ohms designed to feed high-impedance loads with an output of approximately 2 volts while the other is designed to feed a 600-ohm line with a level of 0.2 volts. A third output jack is provided, normally wired to the high-impedance output, but available for connection ahead of the de-emphasis network, if desired, for multiplex operation or for use with certain types of stations which transmit ultrasonic control signals to cut off commercial announcements. The antenna connections are made through a built-in receptacle which accommodates 300-ohm transmission-line plugs.

Circuit Arrangement

From the circuit standpoint the Precedent differs appreciably from any other tuner we have examined. The input to the first grid of the 6BK7A cascade r.f. stage is double tuned, as is the transformer between the r.f. stage and the first detector. A 6JS is used as the mixer and oscillator, with the oscillator coil consisting of a silver winding deposited spirally on a glass tube. Added selectivity and protection from near-channel strong signals are provided by this additional double-tuned circuit.

The i.f. amplifier consists of five stages, with flat-topped tuning to provide a band pass of 170 kc at the 6-dB points. The second and third i.f. stages (as well as the input section of the r.f. stage) have their grid returns connected to the r.f. gain control so as to adjust sensitivity of the user's local conditions.

A voltage pre-limiter amplifier follows, using diodes in the grid circuits as grid resistances; the signal meter is connected in the grid return of the third of these stages. Two limiter stages follow, with diodes actually serving as limiters while the tubes themselves are amplifiers. The diodes remove amplitude modulation from the signal. The wide-band discriminator follows, and it in turn feeds a cathode follower output stage, with feedback from the follower to the first audio stage.

The power supply uses a 2Y3G rectifier, with choke-capacitor filtering for audio frequencies, and with numerous r.f. choke-throughout—nine being used in the plate and grid supply section, and seven more in the heater supply circuits. It is not likely that there is any stray r.f. anywhere in this receiver.

Performance

The performance of the Precedent at a location 20 miles east of New York city indicates a high degree of sensitivity. With no connection to the antenna input jack, there was no signal whatsoever anywhere in the band. With four inches of wire in one of the jacks, every N.Y. station came through with good contact. The Crestwood engineers as well as the Philadelphia station was picking up with a signal-to-noise ratio of approximately 15 db. Philadelphia is nearly 100 miles air line distance, but it is 30 deg. off the Yagi. Rotating the antenna to maximum signal gave completely satisfactory reception from the Philadelphia station.

No a.f.c. is used in the Precedent, but the stability is such that none is necessary, and dial calibration is accurate enough that one can tune in a station with the volume down, using only the scale calibration. Then when the volume is turned up, the station is there. Judging from the tuning meter there is no perceptible drift from cold start through ten hours of continuous operation on the same station. Again turning the set on after an overnight cooling period, the station was found to be tuned in properly.

The signal strength meter is an interesting feature. Instructions indicate that the r.f. gain control should be set so that the meter is from ½ to ¾ scale for avoidance of overload of the r.f. and i.f. stages. This should be normal operating procedure. But with the gain control at full on position, signal strengths are indicated by the position of the pointer—ranging from 40 µw at scale position 1 to full scale. With the gain control at the half-way position, signal strengths ranging from 40 µw to 70,000 µw are possible.

Our observations indicate that the Precedent well justifies its reputation. It is the logical answer to the demand for a maximum of quieting, high sensitivity, and excellent stability. It is especially recommended for use by anyone who needs a reliable FM tuner for such applications as recording off-the-air programs, where any noise is intolerable. It is also recommended for locations where signal strength is something less than ideal, and it would be appreciated for its engineering, for its performance, and for its external appearance—tops on every count.

RECHECK FOR CRESTWOOD 304

Since our findings differed somewhat from those of the Crestwood engineers as to the performance from record in to playback on the Crestwood 304 recorded last month, we are going to have another go at it. It is just possible, suggest the Crestwood people, that (1) we made a mistake, or (2) one switch contact was not making good contact. Since the playback from standard tape curve checked almost exactly with theirs, we think that one or the other of these possibilities is correct, and we shall look again.
I S THERE anyone who hasn't yet heard of Edgard Varèse? He is the man who suddenly became famous a few years ago as the first taped sound became famous, and his name ever heard of. Is the name and his work a new one to you? I assure you, the work was presented to you in a rather unique manner.

Varèse's sudden hi-fi fame was a bit delayed. He wrote the music 'way back in the middle Twenties, when hi-fi hadn't even heard of. But, as we all discovered at several Audio Fairs and a couple of thousand home and sound-saloon demonstrations, Varèse's music is the right stuff for hi-fi equipment yet produced—and competition is pretty hot on those lines right now.

Well, Varèse is at it again (1952-54) and a few weeks ago I was planked down right in the middle of his newest opus, a work with the ridiculously modest title "Deserts."—Oh yes, I know you're going to ask me if it is the most overwhelming sound I have ever heard. It wasn't really any coincidence that "Ionisation" so nearly anticipated the sounds that we hi-fi bugs now like. Nor is it hard to see that "Deserts" may be equally charming in respect to the further future. For Varèse is one of this century's most imaginative minds. His music breaks along with the experienced.

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GHOSTS IN BROAD DAYLIGHT

A S LONG AS I'm with this magazine (or any other) I will never do a ghost review—that is, a review under my own name that in actuality is by somebody else. I hear tell of such things elsewhere and I can hardly blame those who find that two ears and one mind just aren't enough to keep afloat with, today, under one name. Ghosting was a brilliant idea and still is—you can have your cake and eat it too. Moreover you can always say that you have seen the material and approved of it, as do our other editors who read their own ghosted speeches out loud!

But not here. I began an experiment this month which will help us better to cope with the ever-increasing floods of new records, so many of which today are merely repeat recordings of works already released several, or maybe a dozen times. I'm a slow listener and I'm glad of it, though it would be nice to be able to run all records at 78 1/2 rpm (or maybe 78) and "decode" them into neat critical reviews in half the time. That's impractical. And so I'm getting in some outside listening help—and telling you so.

GHOSTING in broad daylight, you might call it, though the actual comments, as you'll find, are written by myself. The records which follow have not been played by me. The listening is by somebody else—the responsibility is mine. A scout who shall for the moment remain ghost-like and anonymous has played them all and attached informative little typed cards to each, for my (and your) benefit. On the basis of these I have rejected many discs, saved some on his recommendation, and have added my own comments as the situation seemed to require. The writing, I hasten to repeat, is entirely mine, non-ghost, except for quotes, direct and indirect, as indicated. But I have the benefit of scout's counsel, as you will see.

The material I have submitted for this daylight ghosting is, you will note, mainly of the standard concert repertoire sort. I've been checking with this particular idea on such works for a good while now and I think I know pretty well when we're liable to disagree and what sort of music will get a useful and fair criticism from this source.

If the idea works—and I'm quite enthusiastic about it—I may call in other plainly labelled ghosts as well. And who knows—they may eventually blossom out into real, live record critics!

We'd be glad to have your comments on the new system, after you have read through this month's contribution.

Our Scout Tells Me...

(Notes: These comments combine my own observations with those of "Scout #1," as described above.)

TCHAIKOVSKY & CO.


"Eminently sensible and practical coupling," writes Scout #1, and he says the recording is extremely fine; performance is good, respectable, if a trifle under the Mendelssohn is sure and strong. This agrees exactly with my previous hearings of his playing. An excellent bet and economically, too.


Our scout likes the Mendelssohn, especially in the last movement, and expects Mitropoulos to do an outstanding job with the orchestra in Mendelssohn (though he thinks the Tchaikovsky's balance is poor—to much violin, the orchestra at a distance. This is the sort of dishful of chestnuts, I should add, that almost easily falls into routine virtuoso hackwork, in spite of top talent. They have to play the works so often, that the genuine feeling is desperately hard to invoke, on order.

Tchaikovsky: Violin Concerto in D. David Oistrakh; Saxon State Orch., Konwitschny. Decca ML 9725.

One side for this on Columbia, above—a whole record here on Decca. Scout #2 calls the fiddling superb, which is what can be expected from this highly musical Russian. But the orchestra again is too distant, he says, and the recording is only adequate. If you collect Oistrakh (which is worthwhile), try this one.


On Columbia's lower-priced label, this is a reissue, together with numerous others, of the excellent recordings of the era just before LP, the originals, if I am right, having been wide-range 16-inch disc transcriptions—well ahead of their time in quality. Not up to current standards but ahead of much material from other companies from those days.

Scout #1 calls the Rodzinski recordings well organized, straightforward performances, without fancy tussicums for conductorial effect but on the whole a bit colorless; this is about the way I remember them from their original releases. He thinks that this one, the "Pathétique," is outstanding, one of the best versions, of any sort, on LP. Sounds like a very good bet.


Priesay has been one of my favorite European conductors in many past recordings; when our scout reports that this is the finest version of the Serenade he's heard, I'm inclined to think—just what I would have expected. (He refers to another version, which I will tackle at a later time, as "a seven-course dinner of whipped cream—ugly").

The Prokofieff, he says, is surprisingly like the recording classical by disc transcriptions (which I liked a lot); a deliberate tempo in the first movement. Tightening to a real "Russian" pace and strength in the finale. In both the orchestral recording is reported to be excellent with fine string tone. (A Deutsche Grammophon job.)


This unusual little symphony will produce pleasure in many an ear that is jaded as far as the bigger and later Tchaikovsky symphonies are concerned. Not a "great" work and it has its typically noisy moments, but you'll find a youthful freshness in it, now and then, that is ingratiating.

Our informant thinks this one is musically not as free and supple as an old 78 rpm RCA version by the same orchestra under Casadesus, but he prefers it to two Columbia versions, by Mitropoulos and Boeheim. That sounds a bit drastic, I must admit (I'm not going out right now to test all three) but it poses a bit of a challenge to readers who can get to make their own comparisons. Sir Thomas Beecham is quite capable of being the prima donna on occasion, acting the coy eccentric—as he's equally capable of turning in a splendid and serious job on plenty of other occasions.

In any case (says Scout #1) this version has much the best recording, and I add that Remington, in spite of incredibly low prices, now is able to turn out a quality of sound that is easily competitive with more expensive discs. In particular I note that the early grainy hiss of the Remington material has now vanished; the background is as quiet as in many a higher-priced line, though whether the material is as durable I do not know.


Kostelanetz has been doing "classical" scores for some time now and the pattern has had time to set rather solidly. He has a high-priced orchestra and it performs in a high-priced way, that is, a perfect blend, as usual. No wrong notes in this ensemble. The resulting sound, with Columbia's finest recording, is inevitably dour—indeed it invariably sounds just like Kostelanetz.

A casual listener, therefore, is apt to be entranced, by such utterly polished music. I've been so myself. But on closer inspection there grows a certain tastelessness, a lack of character, a wood-
ennness of expression which, in music of any subtlety is absolutely disastrous to the sense. (I'm reminded, for instance, of K.'s "Mother Goose Suite," which had a positively deadly dull quality to the audience to which I hear it played to.) It's not at all easy to detect, this soundlessness, and I'm sure that the Kostelancik recording, well noticed in the past, is far too pretty to please the ears of folks who aren't too choosy about classical detail work so long as the over-all sound is as gorgeous as these recordings always are.

And so I can only convey when Scout #1, full of zeal, called this a "dull" pedantic reading, the orchestral chairs out of balance—probably the fact that thick Kostelancik's string tone." aconcertante performance with no need paid to the ability of the tempos. Again—about what I would expect.

The Urnone, on the other hand, pleases him for its excellent dance tempo (which will be important for many dance-minded listeners and, incidentally, serves to cover up some of the uncalculated playing) and the recording is relatively recent, with Urnone's use of "59-1500e" imprint on its cover.

But I take it, that is of Eutin Berlin, whereas the RIAS is the Berlin Radio-in-the-American Sector. On records the Iron Curtain is sort of personalized.

BRAHMS

Brahms: Violin Concerto in D. (a) D. Oistrakh; Saxon State Orch., Konwitschny Decca DL 7954. (b) Gioconda De Vito; Philharmonia Orch., Schwarz. His Master's Voice LHMV 539.

This would seem to be a case of an excellent record—-the HMV version with De Vito—stacked up against the work of a violin genius—Oistrakh. Our sound calls the HMV version to be better as to sound and says the Philharmonia's playing is good—in fact excellent (and all this in spite of the relative unimportance of these names, too).

But Gioconda De Vito, of the operative name, doesn't stand a chance next to the effortless strength of Oistrakh's performance. "Such sweet- ness of tone! Such cleanly articulated phrasing. She has worked out a good concept of this big work and she has plenty of temperament, he says, but her tone is harsh-seeming, her capacities strained, when she's compared directly to the fabulous Russian. I've heard a bit of the Oistrakh myself and have listened to a number of his earlier recordings—Beethoven Kreutzer Sonata, a Mozart Concerto—with considerable wonder. Too often, these days, a new sensation like Oistrakh, plastered with all the high-powered publicity now available, turns out to be just another pretentious, being pushed hard from behind by those who stand to gain. I'm frankly cynical about such matters. It seems to me that even the really great names (the ones, at least, who happen to get into the right situation or the right personality) often get pushed too hard, to their own detriment. It seems to me that the later Toscanini fame was of this sort, and what ripened uneventfully and still is but his last recordings—and performances were not his greatest.

And so, to conclude my own addition to this particular "review," I was honestly astonished to find that the famed Oistrakh really is a great violinist, and, at least in the sound, a modest, lyric, unaffected performer, rather than one of those mechanized powerhouse of technique so prevalent these days. I'm all for him and I highly recommend his recordings, including this one.

Brahms: Symphony #1. N.Y. Philharmonic. Col. Enrico Pier. Same good comments apply here as to the Telashowsky "Pinchtagge" reviewed above, but our scout is not enthusiastic about this performance. "Much like the super Waller version on Columbia but without that one's blare and imp personal points." With this I would likely agree, since I found the Bruno Walter versions of the Brahms symphonies profoundly moving. Again, a reason why but without better technical quality than might be expected for its age.


This one, says our informant, is "the peer of any of the 15 or 16 readings currently on the market" and splendidly recorded, too.

"It does not have the warm, passionate Roman

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ticism of the Walter reading, nor the kinetic vitality of Toscanini's, but it is as soundly con-
cieved as either, better articulated, better balanced in the orchestral ethos. I Ta, it would seem to sum
up very nicely. He adds that the "celebrated Amsterdam brasses especially shine" and I add
that this ought to make it a good bet for high quality. Even that Epic's recording has risen up to
top quality levels.

MAHLER

Mahl: Symphony #8 ("The Symphony of a Thousand")

Epic SC 6004 (2).

Thanks be to our indefatigable Scout for plough-

ing through the morass! I did the second, though I
did put the project off until I could find a long,
relaxed evening—which will never come. I am an
ardent admirer of Mahler when that real genius
manages to confine himself to what in our times seems
a superficial moment, which they all contain, moments
that no other composer can equal.

This one was one of the vast attempts to carry
music to Commoners, or, in his own word, to preoccupied
Mahler in particular, as well as plenty of others
in his day. (Eleven of his chief Boston Jubilee
festivals in the 70's brought together performing
groups as large as 20,000 people—all going full
blust at once! Those were the days before Public
Address knocked the excitement out of Big Noise.

My scout feigningly describes this mammoth work
for a mere thousand performers as "insufferable,
perpetuous and interminably boring," which, I
happen to say, is an honest reaction that will ap-
ply to many listeners, whatever be their "feelings" may
be. But, as he suggests, the work "has its ad-
\vantages" and I am sure that it also has its won-
cerful moments, even if, indeed, just as it seems
he can be summoned up to wait for them. He notes
that this version, though undeniably and blazoned as
might be expected with a mass of a thousand
performers, is nevertheless superior to the Columbia
version of another conductor back from Vienna (SL 164),
both in the recording and the performance.

But this isn't enough—our optimistic scout goes on to suggest that Mahler fans might do well to
"hold out for a more clearly articulated sound,"
or some future recording yet to be made. What
With a thousand performers? Fine chance, is all
I can say.

Somebody might try a bit of real hi-fi technique on
the Symphony of a Thousand, to be sure. That
is, 559 miles, mounted every 12 feet throughout the
1000 performers, Things and noise be heard wherever
and wherever nobody, but nobody, would ever be
more than a few inches from the nearest cardboard
or condenser. Mix all 559 together (on some super-
electric mixmaster of a control board) and you'd probably
get the same old fuzzy blur all over again. Mahler knew what
he wanted.

Our course another approach might be an
arrangement, to adapt the music for better recorded
sound. Say a recording ensemble of about ten
voices and maybe sixteen instruments. Indeed,
Mahler would turn in his grave, naturally; but
if Mahlerites objected, as they probably would,
then somebody would be bidden to come up with
the inevitable solution—run the whole thing
through an electronic reverberation generator and
to make a ten-plus-sixteen players sound again like
a Thousand. No sooner said than done! But
whoops! We throw that grand old blur right back into
Mahler's head. Mahler really did know what he was
doing and we might all well take it or leave it,
via Epic's very reasonable version. It's a Thousand
or nothing.

Mahl: Symphony #1

(a) Israel Philharmonic Orchestra, Kletzki.
Angel 35180. Col. SL 218.
(b) N. Y. Philharmonic, Walter.
Col. SL 218.
(c) Minneapolis Symphony, Mitropoulos.
Col. Ente R 3120.

Mahler really gets around these days—here are
three out of some nine versions available, as listed.
To be sure, of the nine, one is conducted by Bor-
samti with the Radio Berlin Symphony (Van-
guard) while another is by Borssamti with the
Radio Berlin Symphony (Urania), but we mustn't
let petty duplicities (?) like that bother us. Well . . . eight versions.

Except that two of them are by Mitropoulos and the Colossus,
the Colossus issue now being replaced gradually by the same
performance, as above, on the cheaper Ente label.
Seven versions, then. Seven versions is still a
lot.

Scout #1 is impressed by this first release from
the Israel Symphony on Angel. He notes it as a
performance "somewhat different in emphasis and
generally more modest than the original," which
are surprisingly alike in these respects" and though
I am sure his judgment on the Angel is good, I
longing to try a bit of the other, concerning at
least some of the other versions, those noted above.

The Mitropoulos Mahler First was one of the
first records I remember reviewing, back around
1938 I'd guess. It was also my first crack at
Mahler in any intimate way and I was crazy for
the first movement, but put the project off until
the most hopefully noisy ending I had ever experienced.
Little did I know Mahler in those days!

The scout Bowerman version astonished me,
because he tackled the long, slow, static introduc-
tion—static as Mahler himself had it— the four
Symphonies leave me behind pretty quickly—
though I bounce back again every so often at the
superb moments, which they all contain, moments
that no other composer can equal.

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music to Commoners, or, in his own word, to preoccupied
Mahler in particular, as well as plenty of others
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Symphonies leave me behind pretty quickly—
though I bounce back again every so often at the
superb moments, which they all contain, moments
that no other composer can equal.
Ravel: Bolero, La Valse,Valses Nobles et Sentimentales, Alborada del Gracioso, Pavane pour une Infante Defunte, Orch. du Th. Champs-Élysées, P. de Freitas Branco.
Westminster WL 5297.

Ravel: Bolero, La Valse.
Honegger: Pacific 231.
Dukas: Sorcerer’s Apprentice.
The Paris Conservatory Orch., Ansermet.
London LL 1156.

These two should have plenty of hi-fi appeal, for one thing. Our scout finds both brilliantly recorded, the Westminster “spectacularly so” (no doubt with Westminster’s ultra-brilliant close-up technique of microphoning), the London “with better balance and fuller body.” Both discs are well chosen collections of related hi-fi-style material, and those who know the respective Westminster and London styles of recording will hardly be dissatisfied in either case.

The two feature pieces on both, Bolero and La Valse, Scout #1 finds musically not too satisfactory: both feature slow tempi that, he feels, detract from the vivacity and drama of these two sous de force of dramatic climaxes.

Debussy: Nocturnes for Orchestra (Nuages, Fêtes, Sirènes),
Ravel: Rapsodie Espagnol, Menuet Antique.
Paris Conservatory Orch., Fournet.
Epic LC 3048.

Scout #1 is full of enthusiasm for this disc and feels that these are “definitive” performances. He particularly likes the Ravel Rapsodie which he says has no equal on LP by a wide margin and makes a remarkable listening experience.

I must add that Fournet’s work in other recordings I have heard recently would confirm this judgment he is evolving into one of the best conductors of French music we have on records. The Scout speaks of the “distinctively Gallic sound of the horns, the third movement of the Rapsodie —this of course, would be due to the peculiar French-type instruments, quite unlike the ordinary ‘French horns’ horns of the other composers and played with a tell-tale vibrato, like a saxophone, where all other horns play without vibrato. The French-style horn playing is absolutely drenched in Wagner or Bruckner, but in French-composed music it is needless to say, entirely French and proper.

An adequate recording, not as fancy in sound as some competitive versions (Mercury, Angel)—this release dates from awhile back (last summer) before Epic had hit the hi-fi stride it now maintains. Get this one for the music, not the disc.

Franck: Symphonic Variations.
Faurot: Ballade.
Saint-Saëns: Piano Concerto #5; Jean Doyen; Magda Tagliateto (Saint-Saëns); Lamoureux Orch., Fournet.
Epic LC-3057.

Another Fournet-conducted disc and one scored (as usual for the French) again approves heartily. The Saint-Saëns, which in the hands of the Lamoureux Orchestra and Fournet. A first class musical offering in all respects, it would seem. (Indeed, I trust this account so well that I’m going to have to put the disc aside and play it again for no other.) I expect it to be a pleasure. There’s nothing like French music well played.

Recording, Scout says, is “good middle-period Epic.” Readers will remember that this departmentCooler takes exception last year to Epic’s initial difficulties with the new Phillips imported recordings and prophesied that these would soon improve. They have and Epic is out in front soundwise this year. The present disc dates from the end of last year when they were beginning to go well technically—hence, “good middle-period.”

Remington R-199-183.

Offenbach-Rosenthal: Gaité Parisienne.
Columbia ML 4895.

Three ballet scores adapted from 19th century works not originally ballet-intended, but two of them, at least, are so well known now as to be more famous in the ballet form than in the original. Ballet suites of this sort have had wide popular success as musical numbers (minus the ballets) and so it’s not surprising that Manual Rosenthal has tried to follow up the phenomenal success of his “Gaité Parisienne” with another from the same composer.

“Lightning seldom strikes twice” is Scout #1’s succinct comment on the Remington “Offenbachiana,” above, that is the result. He thinks it of little interest, though the playing is “live and bouncy” with nice orchestral coloring. In all truth, Offenbach wrote some pretty trash to pad out the relatively few bits of really fine music in his enormous output of opera. It takes a very careful search to come up with music as consistently good as “Gaité Parisienne.”

As to “Gaité” itself, on Columbia, Scout reports it is a fast virtuoso concert performance, overbrilliant. This, I’d say, is what usually happens when a top virtuoso orchestra takes up a popular light item and makes a big thing of it. “Sylphides,” he says, has a fine string sound (it’s predominantly a string piece, arranged from the piano originals) not too heavy and beautifully recorded.

SUSPENSION SPEAKER
(from page 20)

Figure of merit a strange correlation could undoubtedly be made between the features of a particular manufacturer’s speaker and the qualities emphasized as most important to the figure of merit. Manufacturers of low-efficiency speakers would tend to deny the relevancy of efficiency, while manufacturers of high-efficiency speakers would probably take an opposite stand.

At the risk of the writer’s seeming to have an axe behind his back in need of grinding, it is submitted that efficiency should not appear in the main term of a figure of merit for loudspeakers, but in a second term connected by a plus sign. The second term would include other factors such as price and size. Low efficiency simply means that for given performance results more money, weight, and space must be invested in amplifying equipment. The relative cost, in terms of these three factors with added electronic capacity can be calculated, but should not be reflected in the index of quality.

In the case of the Acoustic Research speaker, efficiency has been deliberately traded for extended uniform bass response and low distortion. It is obvious that the magnetic circuit used in the AR speaker is sufficient for a motor of very high efficiency. The sacrifice of efficiency is justified, in the mind of the writer, by the performance data reported in this article.

High-Frequency Speaker

The high-frequency speaker used in the model AR-1 system is an 8-inch direct radiator. Its performance characteristics, as used in the system with a 12 db/octave bass-droop network and pad, and as measured by Acoustic Research, are: frequency response 800—13,000 cps ±5 db, and distortion over above range with 10 watts input, 1 per cent maximum.

PILOTONE AMPLIFIERS

PA-913 PILOTROL Professional Pre-amplifier-Equalizer, an innovation in audio control—and other fine products, including the portable Encore; reflect the Pilot “Standard of Excellence.”

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37-06 36th Street
Long Island City, N. Y.
HEATHKIT'S generators, with similar characteristics. GE though designed is used 000 devices.

A new concept of the enclosure. When finished, the enclosure allows an internal volume of 12 cu. ft. and measures 20" x 11" x 10". It is of the "distributed-port" type, with half-inch acoustic lining. The speaker opening in contained behind a metal cloth grill which covers one entire side of the enclosure. Because all four sides are finished, the unit can be mounted in any desired position. By adding legs of wood or wrought iron, it can be used as a console. General Electric Company, Electronics Park, Syracuse, N. Y. L-5

University Paging, Talk-Back Speaker. Exceptionally wide horizontal dispersion is afforded by a new concept in wide-angle speaker design recently introduced by University Loudspeakers, Inc., 80 S. Remmick Ave., White Plains, N. Y. The Model CIB comprises a built-in hermetically-sealed driver unit assembled to a reflex air column terminating in a cloth-covered wide-angle cone. The bell is a piece-one mold of Fiberglass-reinforced polyester which is strengthened with a full-length steel bend. The driver unit is treated with an anti-fungus compound for complete weatherproofing. All exposed metal surfaces are electro-chemically plated against corrosion and are finished in gray peel-laminated enamel. The CIB is rated at 12 watts continuous duty with a response of 50 to 13,000 cps. Horizontal and vertical dispersion are 150 and 60 deg. respectively. The Model CIBL is a similar introduction to the CIB except that a screw-in driver is used. It is rated at 3 watts continuous duty with a response of 100 to 15,000 cps. Free illustrated brochure will be mailed on request.

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Hi-Fi International AM Tuner. Both standard broadcast and short wave bands are covered by the new Series 2100 tuner, now available from Scott Radio Laboratories, Inc., 1570 N. Rush St., Chicago 11, III. Tuning range is 50 to 20,000 kc in three bands. Unique features include vari-

---

Resistance - Capacitance Substitution Box. This instrument, available fully wired or in kit form, provides 36 standard RTVMIA resistor values ranging from 15 ohms to 10 megohms, and 28 capacitance values from .001 to 22 microfarads. Accuracy is within 10 per cent. It is well-suited for determining proper values in the design of R-C circuits, also for learning the original values of charmed or unmarked resistors and capacitors in service equipment without a schematic diagram. Designed Model 330, the box is manufactured by Electronic Measurements Corporation, 210 Lafayette St., New York 12, N. Y. Complete technical details are available on request.

---

Disc Recording Power Amplifier. Power output of 150 watts with less than .05 per cent rms harmonic distortion from 10 to 15,000 cps is characteristic of the new recording, including push-pull output amplifier recently announced by Gotham Audio Development Corp., 2 W. 46th St., New York 36, N. Y. At 100 watt output distortion is less than .15 per cent. From 20 to 10,000 only 3.5 to 4.5 per cent distortion is held below one per cent at rated power output, while damping factor exceeds 60. Instantaneous peak power of 400 watts is available with complete stability. Noise level is 72 db below 10 watts output. Balanced and unbalanced inputs range from 100 to 10,000 ohms are available, while output impedances range from 8 to 33 ohms. A gain control adjustable in 2-db steps and direct output-tube plate metering are provided. The amplifier proper consists of six push-pull stages balanced through use of one-per-cent tolerance matching resistors. Output tubes are 811-A's biased positively for minimum distortion. The unit will accommodate every cutout panel made for disc recording, including the British-made Gramophone for which feedback connections have been provided. Built for standard rack mounting, the unit occupies 21 ins. of vertical panel space. Further information on request.

---

Extended-Range Voltmeter. Both portable and precision are inherent in the improved version of the Model 329-A voltmeter manufactured by Waveforms, Inc., 553 Sixth Ave., New York 14, N. Y. Performance as voltmeter, null indicator, and wirewound decade amplifier is independent of line-voltage interferences and external stray fields to an excellent degree. The unit operates on alternating-current or direct-current frequencies from 50 to 400 cycles. Full-scale sensitivity of 1 mv permits measurements as low as 50 microvolts. Ranges are provided up to 300 volts, as well as from -7 to +55 volts. Frequency response is 1 volt per meter in from 10 cps to 2 megacycles, and as a null indicator from 2 cps to 4 megacycles. The instrument may be carried in a standard briefcase and is designed for the

(Continued on page 46)
McINTOSH
HIGH FIDELITY UNITS
50 Watt AUDIO AMPLIFIER
Model 50 W-2
A novel and unique circuit design is employed to provide 50 watts of continuous power (100 watts peak) with amazingly clean, distortion-free reproduction. Frequency response extends from 20 to 20,000 cycles, 2.5 dB, and from 10 to 100,000 cycles, 3.5 dB. Distortion is less than 1% over the entire audible spectrum at full 50-watt output. Phase shift is negligible. High drive input fader and other features contribute much to the outstanding listening quality of the 50 W-2.
Complete with tubes $249.50

PROFESSIONAL AUDIO COMPENSATOR and PREAMPLIFIER
Model C-B
A complete, flexible front end unit with 3-position selector switch for AM, FM, Phone. Microphone, TV, Tape or other program sources, has built-in variable ringer filter. Five sliding-switch, turntable controls used individually or in combination permit 11 turntable settings from 280 to 1340 cycles. Another series of five sliding switches allow up to 11 treble curves. There is a volume control plus a 5-position compensator which maintains bass and tone balance at all levels. A variable input resistor, calibrated from 1K to 100K ohms, terminates any magnetic cartridge, with correct load for optimum performance. A switch provides equalization for FM or ceramic cartridges. Power is obtained from the main amplifier or from separate power supply as listed below.
C-BM - with tubes in attractively styled cabinet $96.50
C-BPM - as above, with auxiliary power supply 107.50
C-B - with tubes, less cabinet 88.50
C-BP - as above, with auxiliary power supply 99.50

CABINET FOR 2415
Blonde or Mahogany $99.50
Bose Skirt (as shown in illustration) 15.00

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REMOTE CONTROL TELEVISION RECEIVER CHASSIS
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Two-chassis, remote control TV receivers designed for custom installations. Circuit employs 27 tubes, exclusive of picture tube. Audio amplifier supplies power for existing speakers, also low level high impedance cabs and follower outputs to feed complete sound system. Remote encoder embodying all controls can be operated 4 feet or more from picture chassis. Supplied complete with tubes, but less picture tube, mounting bracket and knobs.
Model 600 - for 21" (70") rectangular picture tube $264.50
Model 700 - for 24" and 27" (90") rectangular picture tube 289.50
NOTE: These receivers may be obtained with self-contained controls on one chassis (without remote control). Models 610 and 710, priced at $199.20 and $219.30 respectively.

Note: Prices Net, F.O.B., N.Y.C. Subject to change without notice.

AMPEX 600 PORTABLE TAPE RECORDER
A high quality tape recorder designed for professional broadcasters, recording studios, and other critical use. Weighs less than 28 lbs. Ideal in performance to the console model 350. Has separate areas, record and playback heads, also record amplifier and separate playback amplifiers with 1.25 volt output. Meter permits continuous checking of recording level. Tape width is 3/4" inches. With a frequency response from 40 to 10,000 cycles. 20 db and to 15,000 cycles.
Complete with tubes, lens microphone $545.00

NOTE: Prices Net, F.O.B., N.Y.C. Subject to change without notice.

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Complete $1500.00

The 3-D ... Standard System
A 3-way system similar in performance to the 4-D Super System, but with lower power handling capacity of 50 watts. Employing 21" 8-waters, one horn mid-range driver and one horn tweeter. Impedance is 16 ohms. Dimensions: 27 x 24 x 24. Shipping weight is 350 lbs.
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The Hi-Fi ... Model 4830
Provides a substantially flat frequency response from 20 to 16,000 cycles. Peak power handling capacity is 50 watts. Employing 21" 8-waters, one horn mid-range driver and one horn tweeter. Impedance is 16 ohms. Dimensions: 25 x 20 x 20. Shipping weight: 220 lbs.
Complete $645.00

The ESQUIRE ... Model 3424A
A 2-way speaker system providing response from 30 to 16,000 cycles. Employing 2" drivers covering 30 to 1000 cycles and a high frequency horn driver operating from 2000 to 16,000 cycles. Power capacity is 25 watts and impedance is 6 ohms. Dimensions: 36 x 24 x 18. Shipping weight: 65 lbs.
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The Lo Sabre ... Model 2415
An apartment sized 2-way system employing an 8-inch bass driver and a 3" tweeter. The bass horn is effective down to 50 cycles and the tweeter extends up to 16,000 cycles. Power handling capacity is 14 watts and impedance is 8 ohms. Dimensions: 24 x 3 x 12". Shipping weight: 22 lbs.
Complete $79.00

The Lo PETITTE ... Model 1911
A 2-way system ideal for restricted space use. Placed horn is effective to 60 cycles. Employing 8" bass driver and a 2" tweeter. Power capacity is 16 watts and impedance is 8 ohms. Dimensions: 23 x 13 x 10. Shipping weight: 19 lbs.
Complete $49.00

All Stan White Speaker Systems employ multi-rate exponential horns providing effective speaker loading and acoustical coupling with air to extremely low frequencies. The multi-rate horn extends farther into the cabinet. All cabinets are available in blonde korina, walnut, mahogany and ebony finishes. Models 2415 and 1911 are equipped with wrought iron legs; all others come with spun-finished brass legs.

NOTE: Prices Net, F.O.B., N.Y.C. Subject to change without notice.
be moved from side to side (in the same plane as the tape movement) by motions of the solenoid plunger.

If the tape is running slow, the polarity of the d.c. put out by the balanced modulator is such as to cause the solenoid plunger to move to the left—opposite to the direction of tape travel. The plunger pulls the head with it. This results in increased velocity of tape travel with respect to the head and tends to correct the slowness. For fast tape speed the polarity is such as to move the head in the same direction as tape travel, reducing the effective tape speed with respect to the head. When the tape speed is correct, the head is held in center position by a pair of balanced springs (not shown in the drawing).

This part of the system takes care of small, fast speed variations such as might cause wow and flutter. The head is sufficiently small and light and the power of the solenoid sufficiently high so that head motion is prompt and fast enough to iron out these small variations in speed. Head motion of more than about 0.1 in. is not usually necessary.

To take care of larger variations and those which are alterations of average or over-all tape speed, the system is extended. On the other side of the playback head a rigid mechanical linkage is connected to (but insulated from) the center arm of a s.p.d.t. switch. The switch is connected to a small motor whose shaft turns the arm of a rheostat in series with the capstan drive motor. The capstan drive motor is not synchronous and its speed may be varied by this rheostat. In center position, the rheostat sets the capstan motor speed at about the normal value. The rheostat motor is reversible and the direction it takes is determined by which of the outer arms the center switch contact strikes.

If the tape speed is slower than it should be, the solenoid plunger pulls the head toward it. The head pulls the center switch arm over to contact the left contact. This energizes the rheostat motor so that its shaft turns the potentiometer counterclockwise, increasing the voltage on the capstan motor and advancing its speed. As the tape speed increases toward normal, the tell-tale d.c. emerging from the balanced modulator decreases, allowing the playback head to return toward center. When the tape speed is correct, the playback head completes its return to center, the switch opens, the rheostat stops rotating, and the voltage on the capstan motor is correct.

As stated earlier, the important feature of this invention is the playback head movement. Average speed correction could be taken care of simply by energizing the rheostat motor from the modulator output. However, the rotor of the capstan motor has a relatively high inertia, meaning that speed correction takes an appreciable time; as a result, sudden speed variations cannot be ironed out in this way and, even more important, because the corrective effect on the capstan motor takes time there would be an appreciable interval between detection of the error by the modulator and completion of the correcting action, during which speed would remain incorrect and synchronization would be lost. With the present system, the two more or less separate mechanisms operate, one correcting small, fast errors, and the other correcting average error.

There are two advantages to the choice of a low frequency, such as 60 cps for the timing oscillators rather than one at perhaps 15,000 cps, even though both are outside the band normally used in motion-picture work. First, it is probably easier to keep the timing oscillators in both recording and playback equipment on the same frequency, since they can easily be made subject to interlocked synchronization voltage from the line in such a way that they are locked to the average line frequency (without being subject to the short-term line-frequency variations). But second and more important, the synchronous motor of the film projector may be operated from a power source synchronized to the timing oscillator in the playback system. This ties the projector and the playback machine solidly together. Then if the playback timing oscillator frequency is a bit high or low with respect to that of the recording oscillator, causing the tape to go somewhat faster or slower than when it was recorded, the film projector speed will increase or decrease by the same percentage, maintaining perfect lip synchronization between sound and motion.

A few further details, mostly mathematical in nature, are given in the patent which, for 25 cents and a note of the number, you can obtain from The Commissioner of Patents, Washington 25, D. C.
of the problematical future. It would seem to me to be the most important factor of all.

In "Deserts," Varèse places his orchestra of live musicians square in the middle of things, as described above, with the loudspeakers to each side. The sound must last long enough for the listeners to catch it from the speakers to pull a fabulously potent direct hitting power in the live orchestra. Don't underestimate the number of twenty musicians equipped with the fire power Varèse here assembles! 100 clean watts of audio is just about adequate to provide a good "balance" (i.e., the live musicians outblasted by the recorded sound), with a bit left over for distortion leeway.

"Deserts" begins with the orchestra. For many long minutes the intensity of percussion, brass and screeching woodwinds (flambeau clarinets, stampepe flutes in an ultra-high register) builds up, with the suspense having become intolerable—the whole is suddenly drowsed out by the first entrance of the taped sound, like some vast double-concerto with a pair of solists. Roars from the left and, as the audience craned necks to see where it was coming from, (more on this in a moment), an answering roar from the far right, then a steady counterpoint of percussive rhythms, enormous, low-pitched groans, huge industrial grunts like dinosaurs ten times magnified. Sometimes both tracks were going at once, for the climaxes, sometimes there were long "solos" for one track at a time.

And after running an extraordinary minute of this dual sound-parade, with audience and orchestra alike absorbed and horrified by this gigantic powerhouse of organized noise—a quick eye could catch Ann McMillan's hand going up behind the Ampex to throw a radio-style cue and Mr. Waldman's hand going up in response, for a conductor-style cue to the instruments; and in the smoothest way imaginable, the orchestra comes in with a blast of new sound as the tape echoes away. The second A section is upon us.

Varèse points out that as the intensity of excitement increases, the length of the opposing sections decreases, for a kind of "stretto" effect, a piling up of hitting-power. The power-up growth and subsidence of this intensity becomes very apparent on the second or third playing and the more you hear the more impressive is the sense of shape and drama and climax that assails you.

At the end of a near half-hour of this highly organized bedlam you are reduced to a state of ninth-nineth exhaustion or exhilaration—no matter which it is (and you're not likely to be any too sure, for that matter). The variety of sound is enormous—the interest never lags, the drama is expertly sustained, and, most interesting of all, the unity of material becomes more and more evident.

Is it music? That's an inevitable question. The Varèse answer is as simple as pie. "You've got me, I haven't spoken yet of "Deserts," as music. That is because Varèse doesn't either. He both dodges that highly theoretical question and explains the piece in one phrase. He calls it "organized sound."

Music, after all, is organized sound. The greatest music is organized with an extraordinarily potent and subtle degree of organization. Sound that is random, unorganized is certainly not music. Not good music, anyway.

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As I have suggested, the consistency of sound between the orchestral and the taped print was quite astonishing, considering their different origins. To be sure, Varèse used a number of taped common orchestral sounds, suitably processed and altered, to bring the music together, catch, and unity when mixed with the factory noises. But a casual ear would have had a tough time picking out the "musical" noises from the industrial ones, so ingenious is the blend. I didn't begin to recognize vylophone notes and the like among the taped effects until I'd heard the tapes a number of times over.

But what one does hear quickly is an actual "thematic" resemblance between sound-clumps—so to speak—of jazz and popular music. A certain heavy grain, of a giant drill or saw, that appears numerous times in numerous forms in the taped sound suddenly suggests a brass and gourds sound between the hi-fi orchestra and the jazz band. No fifty miles of tape Varèse "exposed" inside his chain factories I do not know. But by some inescapable boiling-down process possible only in those few magic soups of sound which are picked out of the rabble, none of them more than, perhaps, a dozen feet in length, for the raw material of organization.

The technological key to Varèse's "organizing" of taped sounds, aside from the inevitable copying and recopying and combining, would seem to lie in the unique tape player Varèse himself in Europe and (I understand) not to be found hereabouts, a variable-speed machine that can change speed almost instantaneously in steps, or in slow fire-siren style, over a wide range of frequency, an octave or more.

On this machine a given sound-clump may be used to "play a time" right up the musical scale in discrete intervals. Varèse had a test tape he played to us with demarcations of a single original sound—a piano chord, a pursed-lip squeal, etc. When the variable-pitch tuning is combined with elaborate artificial prolongation of sound, you may derive a whole "organ" of tonal patterns, dozens and hundreds of them, from a single original and each one will stand in a related and basic relation to all the others.

I looked at the "score" of the taped parts and could recognize at least that, at any酰, almost instantaneous in steps, or in a known and named tape-idea being "played," in one track or the other in both. I'm not at all clear as to how the fantastic mixtures were assembled. Perhaps McMillan and Varèse worked for months and months at some aspects of the assembly process, I heard tell that as many as nine recorders were required at some points to effect the mixing. It appears, too, that some of the tape was assembled in Paris in Varèse's absence—and when his was the tape. Just what those detailed instructions were I cannot possibly imagine, but evidently the "wrong notes" were not wanted any more.

I also watched Varèse "conduct" the tapes as they played and there was no doubt at all that the whole thing was organized and memorized in his mind for "note." He knew every plop, bang, sizzle.
I got to know a few too, before I was done. It's catchy stuff. Just for the fun of it I tried matching sets of the cues for the changeovers between tape and orchestra, counting poops, peaks, booms, thuds up to the precise instant of the cue. I actually got some of them right, as I listened to the performance.

The Set-Up.

Before it's too late, a word about the unique set-up of loudspeakers and orchestra. Loudspeakers to right and to left, of enormous power—and just how were they to be positioned, so that the people in the inner seats would be properly "overwhelmed," yet those in the front rows, a few feet away, would emerge from the concert alive and unharmed? An intriguing problem.

How, also, was "natural" or "realistic" reproduction in a large hall to be achieved in an extraordinarily special case where the sound of loudspeakers had to compete direct, A-B, with the "natural" sound of living musicians?

When I arrived upon the scene there were two batteries of speakers in place all right, but no sound. Somebody had forgotten the speaker cables. Somebody also found that the Ampex gave forth with 600 ohms into McIntosh' hi-impedance inputs, and an SOS had been sent out, to fly in a pair of transformers. Before a sound was produced at all, I had moved in on those speakers, quick like a flash, and hauled them bodily to a new position. I found both sets aimed squarely at the front rows of audience, all of five feet away. Somebody had thought up an idea: lift the speakers up over their heads. And so a carpenter was at work building a kind of crating on which one speaker had already been mounted. It brought the tweeters of the giant Altec theatre speaker system about three feet above eye level—and the front row was already as good as dead, I figured.

We got the thing down on the floor again and the oldest Canby trick of all was called into play. Reflection. Sound source dispersion, for naturalness and realistic reproduction.

We just turned the speakers around and aimed them back into the uninhabited front corners of the big hall. There was a balcony above and twins in each corner, but all surfaces were hard and good reflectors—no soundproofing in this armory. On one side the Altec theatre system now exposed its unlovely rear, complete with assorted paste-on instruction sheets. On the other was a smaller Altec system in a utility box plus a large wooden-only box, draped with a big hunk of old canvas to hide their equally unlovely rear parts. This was no visual feast for the eyes.

But, when Varèse got his tape started with all 100 watts blasting, the results were marvelous!

That is, the sound of each channel seemed to issue from a vast area in one corner of the big armory. The antiphonal opposition was perfect but the speakers were no longer noticeable except to the eye. And as for dispersion, the outlookers in the back of the hall, a couple of hundred feet away, were hit harder than those who were standing immediately behind the reversed speakers. Distribution—at colossal volume levels—was nearly perfect. And a maximum of naturalness (meaning a minimum of apparent distortion, a minimum of "loudspeaker" effect) was achieved by the corner reflection.

There was one further wrinkle. What about the balconies on each side? Well, to tell the truth, nobody in that hall could possibly miss one bit of the sound at such volume. But, to add more perspective, we placed an additional speaker in each balcony, facing away from the audience into the upper corner. The result was excellent, but as I soon analyzed it, not for the reasons we had thought.

The upstairs speakers did add definition for the balcony audience, but more than this they added a wider perspective, a bigger spread of sound-source, to the speakers on the main floor. The result was a noticeably increased all-over naturalness, a better tolerance by the assembled ears for the terrific volume involved.

One of the still-unexplained acoustic phenomena was the fact that the left battery of speakers seemed consistently more natural in sound than the right batch, which had more of a "loudspeaker" sound throughout. (We traded channels on them, to be sure. It wasn't the tape.) Could have been phasing (which we didn't have time to check), matching trouble, or even the quality of the different speakers themselves—the big Altec and a medium-sized Jim Lansing system. (The other side had the smaller Altec, plus separate Altec woofer and, upstairs, the new miniature AR-1 Acoustic Research system.) It would have taken weeks of testing to find out exactly what was happening—but the difference in tone quality was actually rather useful, as Varèse pointed out; it emphasized the separation of the two sound tracks, increased the sense of difference between them. Good. How often we can turn an engineering liability into an artistic asset!

His Grain

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AUDIO • JULY, 1955

nical quality of the tapes themselves, in this acid test alongside an actual orchestra. In spite of an assemblage of top equipment all along the line, there were severe problems that were not too well solved.

Worst of all was the tape hiss, highly audible at the enormous volume levels Varèse required in the reproduction, and made unpleasantly noticeable by the fact that the hiss was turned on and off as the piece changed from live sound to taped sound. We got rid of hum very nicely, after some extra grounds had been inserted here and there and various unbalanced potentials removed by tie-ups and line-cod reversings. But the hiss remained.

Two major causes operated to produce extra hiss, aside from the high level of reproduction. (1) The tapes had necessarily been copied and copied in the processing. This will always be the case in all forms of taped-sound composition in the future. (2) The final tape was double-track, copied from the two separate full-track 1/2" tapes. This materially added to the basic hiss, as was inevitable.

But Varèse himself unintentionally made the most trouble of all. When I arrived he was rehearsing Ann McMillan in a series of hair-raising volume changes on the Ampex controls, for extra tonal "umph." He wasn't satisfied with the tapes as they were, volume-wise. He got the "umph" all right, but with every change in volume, on each track, the change in hiss-level was positively alarming. It came ahead of the music, too, distracting attention at the wrong moments; it added immeasurably to the unpleasant sense of "electronic" sound, as opposed to the velvety silence in the live music background. The distraction, of course, was just as great when the hiss suddenly faded out (while one track was "resting" for a few moments) as when it suddenly faded up.

This was, indeed, distressing. And it took me two days to persuade Varèse that the way to minimize hiss is to leave it unchanged, let it sink into the subconscious background! Better the wrong volumes in the recorded sound itself than this dreadful rising and falling of hiss.

I also noticed a less important lack, not nearly as unpleasant as the hiss. There were in these final tapes no highs, I gradually realized, above about 5000 cps or so. The slap of the whip, the ping of a xylophone, appeared both live and in the recording: the difference in sound was very decided, though ideally there should have been no difference at all. Somewhere in the multiple copying somebody had slipped up, some circuit was awry.

Perhaps it was just as well, for another very clear problem was that of deterioration after many copies. I'm sorry to say that, in direct competition with the live sound, the taped Varèse was to my ear noticeably coarse and grainy. Again, it's impossible to know just where in the assembly process the trouble may have occurred, or whether it was just plain cumulative and inevitable. Nobody else much noticed it and, if it hadn't been for the orchestra itself, playing right there in front of us, the graininess would have been negligible. But, as I say, this was an acid test, and acid tests are always interesting.

Technical conclusion? I think "Deserts," as a very serious and notable landmark in the probable development of taped music, has pointed out some real problems in processing and reproduction that will be of importance to many engineers even though they may have no interest whatsoever in Varèse's artistic ideas. This is merely the beginning of direct-composed music on tape. We have a lot more to come in the future,
be it good or bad, and tape technology will surely have to meet the technical challenges.

A recording of "Deserts," for all to hear? Let us hope so, but don't expect to get much out of it. "Deserts" has two special appeals that simply cannot be put into recorded form. First—antiphonal sound, three-way. Might do it via a multiple-head tape player and a three-track tape. Not otherwise.

And second—"Deserts" makes its most unique impact via the contrast between living performers and taped sound. That, you can understand, can never be transferred to records, ever. And here, of course, is "Deserts" main point. Live performers "overwhelmed" by the sounds of machinery, organized a la Varèse! I wouldn't have missed it for anything.

STEREOPHONICS
(from page 17)

ence take exception, to the extent that a corner horn, designed for corner operation and not merely "adaptable" to the corner, will set up the same pressure field in its quadrant of operation as would an ideal 360-deg. radiator in a corresponding quadrant. Thus one could substitute for a corner speaker system and its bounding walls an ideal radiator at the point of wall intersection, without the walls, with the same field pattern. To simplify this concept, consider a radiator in Fig. 4 (A). Bisect this as in (B) with a rigid wall, and the unused half becomes a "mirror image" as in (C); a second bisection as in (D) gives a corner radiator with the same field pattern and wavefront geometry in its quadrant, as did the original full-field radiator in the corresponding quadrant.

Practice bears out the theory. Everytime the stage has been confined by adding artificial corners, the results have been less satisfying than where natural corners were used. For extremely wide spreads, however, one finds a tendency to notice the speakers instead of the sound. Experiences with three channels and with a third (center) channel produced by mixing the two outer channels would doubtless be interesting. Probably, the full-sized auditorium with theater equipment will be able to afford the three-channel array.

Concerned mainly with sound reproduction for the home, the two-channel system is outstanding whereas the three-channel system would be marginal over the 2-channel. For the largest living room, and for any auditorium up to the little theater size, the 2-channel with natural corner placement has given highly satisfactory results.

The corner, whether for single-channel or stereophonic use, deserves vastly greater recognition than it has received.

"If there is ever a culminating design for a loudspeaker it should be a corner type, for this affords the maximum performance for a given bulk of space requirement." The same paper from which this is quoted contains the essence and history of the art. The closing paragraph

*This is a difficult concept; don't feel bad if you don't see it the first time through. The simplicity of the figure belies the complexity of the idea.

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states, "The principle of the corner speaker is so fundamental—the time should soon arrive that architects will be designing for corner speakers instead of showing house plans with wall speaker installations which were an obsolete fad in the mid 1930's." The recent experiments and public demonstrations with corner speakers in 2-channel stereophony remove any doubt as to the applicability of corner installations which were an obsolete fad (removing any doubt as to the applicability of corner installations). The fact that it has been demonstrated successfully in all applications corroborates it as technically correct. There remains only to develop its acceptance in application to the extent the grand piano has been accepted.

Practice The formulas used by some stereophonic recordists interpreting relations between room size, source size, microphone spacing, and distance appear to be more applicable by violation than adherence. Each case is a law unto itself. Of course longitudinal and chronolateral stereo recordings are always special cases. Considering only the conditional or lateral stereo case, some tentative rules (not laws!) are suggested:

1. For large orchestra, or choir, almost but not quite bracket the group laterally, and keep the miles high so as to reduce the distance difference from microphone to front and rear members.
2. For a small group, spacing wider than for bracketing may be resorted to for adequate separation. A 4-piece jazz combo occupied 12 feet and the miles were nearly 15 feet apart.
3. Even the smallest condenser microphones are somewhat directional above 5000 cps; try to point the directional-maximum lobe at the spot occupied by the mikes.
4. Expect to make mistakes, thereby building experience. Where an at-concert recording is to be made, try to rehearse and monitor the tapes as closely as possible; if rehearsal is impossible a rabbit's foot is suggested.

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**OUT SYSTEM**

(from page 15)

one or two electrostatic tweeters, as shown in Fig. 4 (B) and (C). Three of these tweeters are presently available: the Phileco shown in Fig. 2; the "Kilosphere," made by Columbia Records; and the Kingdom-Lorenz SKL 100. The SKL 100 and the Korting are described in the literature. The author used a Western Electric 640A condenser microphone as a tweeter during the initial development of this amplifier-speaker system. This use of the 640A has also been described in the literature. The high frequencies from the 640A, while clean, were too sharply beamed; the Phileco unit, constructed as a section of a cylinder, diffuses the highs very nicely, especially when used in pairs with one unit on each side of the woofer.

Electrostatic speakers, as such, are not new. The Kyte electrostatic speaker was used with Peerless radio receivers about 25 years ago, and gave cleaner reproduction than the dynamic speakers of that day. The Kyte speaker required a polarizing voltage of about 1,000 volts, however, and insulation ruptures were common.

Basically, the electrostatic speaker consists of a rigid back plate, a very thin dielectric, and a foil membrane which forms the active or vibrating sound radiator. If an alternating voltage is applied across the back plate and the membrane, the electrostatic forces cause the membrane to be attracted to the back

---


9 Data Sheet on Kingdom/Lorenz Electrostatic Loudspeaker, Model SKL 100.

Notes on the Preamp with Presence and the Z729

Over 450 inquiries as to the sources for the chassis parts, the encapsulated choke, and the printed circuit panel resulted from the Miniaturized Preamp with Presence article in the May issue. So many, in fact, that we had to resort to a form letter to answer them all. In many instances we answered questions not covered by the letter. For the information of any others who may be interested, the kits are now available from Harvey Radio Company, Inc., 103 W. 43rd St., New York 36, N. Y.; Leonard Radio, Inc., 69 Cortlandt St., New York 7, N. Y.; and Radio Shack Corporation, 167 Washington St., Boston 8, Mass.

Many of the inquiries centered about the Genalex Z729 tube which serves as the phone preamp stage. This tube is a high-gain pentode with very low noise and microphonic, and is particularly well suited for this application. Two were used in the original Preamp with Presence (Audio, Jan. 1954, but no reprints are available) but the circuit used in the miniaturized version requires only one.

Figure 1 shows the base connections of the tube, while Fig. 2 shows a typical circuit arrangement. With these values of plate load, a voltage gain of 110 can be realized. Changing the plate load resistor to 0.22 meg, the screen dropping resistor to 1.0 meg, and the cathode resistor to 2200 ohms will provide a voltage gain of approximately 180. The tube was used with the higher values of plate and screen resistors in the MPWP.

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Fig. 1 (below). Base connections for the Z729 high-gain low-noise pentode used in the miniaturized preamp.

Fig. 2 (right). Typical circuit arrangement giving a voltage gain of 110 per stage.

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**Fig. 4.** A high-pass filter, so that the tweeter is worked at normal listening levels only above 7500 cps. The exact component values shown in Fig. 4 are for the Philco units used with a special woofer; the experimenter will certainly want to vary these values for different makes of speakers, different types of enclosures, and different room acoustics. The capacitance of the Philco unit is 0.024 µf. The approximate composite and overall response curves are shown in Fig. 5.

A polarizing potential of around 250 volts is suitable for both the Philco and the Korting, and the connections shown in Fig. 4 will provide this value. The voltage may be increased to 450 volts or so for the Philco and Korting (but not the Kingdom-Lorenze), and in this case terminal B in Fig. 4 should be connected to terminal D rather than B in Fig. 3.

The circuit symbol for an electrostatic tweeter is as shown in Fig. 4; the outline of a crescent indicates the rigid back plate, and the arc to the right of it indicates the foil radiating surface.

The author believes that for the best results in the natural reproduction of sound, the amplifier and speaker system must be considered as an integrated unit. The performance of the output stage is intimately related to its load,10 the phase shifts in the speaker or speakers are very important in determining the behavior of an over-all inverse feedback loop.11 Much work is still to be done before we really know how to measure the transient response of an audio system.12 The author hopes that this article will add to the interest in direct-coupled amplifier-speaker systems, and that those who build this amplifier will be stimulated to make improvements in it and report their improvements in the literature.


ABOUT MUSIC

HAROLD LAWRENCE

DURING INTERMISSION at a recent Carnegie Hall concert, a critic regaled us with the following anecdote: A Pari-
sian family had invited a country cousin about to be drafted to visit with them for a few days. They wined and dined him and took him to a performance of Car
negie at the Paris Opera. During the entire first act, the cousin behaved in a rather strange manner, ignoring the activity on stage and staring intently at the empty seat in the pit. As soon as the curtain fell he leaped to his feet and, with a hastily murmured "Pardon," rushed down the aisle. A trombone player was just getting up to examine the young man beckoning to him. He went over. The young man then asked the musician if he would not mind letting him examine this instrument. Why? Well, he just wanted to be of some help. Before you could say, "Georges Bizet," the trombone was snatched from the player’s hands; and, with a screech of metal, it was wrenched in two. Beaming, the young man handed the pieces back to their bewildered owner with a flourish. "Voilà!"

In case you are as puzzled as the poor trombonist, a word of explanation. The musically uninitiated cousin from the provinces imagined that the player was vainly struggling (particularly during the Over-
ture) to disengage the slide from the bell joint. It’s a good story, especially when ac-
companied by effective pantomime.

Actually our highly improbable young Frenchman is not so far removed from more experienced music lovers apparently under the spell of Euterpe. Have you ever scrut-
nized concert audiences, wondering what was going on behind many of the rapt ex-
pressions? In Tom Jones, End, the English novelist E. M. Forster penetrates the inner thoughts of members of a middle-class Ger-
man-English family attending a perform-
ance of the Beethoven Fifth at the Queen’s Hall. There’s "Helene, who can see heroes and shipwrecks in the music’s foam......"

Tibby, who is profoundly versed in counter-
point, and holds the full score open on his knee......their cousin, Fraulein Mosebach, who remembers all the time that Beetho-

ven’s Ninth Symphony is ‘echt Deutsch’ and Fraulein Mosebach’s young man, who can remember nothing but Fraulein Mosebach......"

"At the end of the first movement......Helene heard the tune through once, and then her attention wandered, and she gazed at the audience, or the organ, or the architecture. Muci did she not hear the abstract Cubics who encircle the ceiling of the Queen’s Hall, inclining to each other with vapid gesture, and clad in a gown which is the October sunlight struck. ‘How awful to marry a man like those Cubics,’ thought Helene."

With the exception of the Pastoral, none of Beethoven’s symphonies can be described as program music; and yet more fantasies seem to have been evoked by these abstract works than by many other blatantly sugges-
tive pieces. Beethoven’s Seventh, for exam-
ple, provided the inspiration for a little essay published in Boston (1941) by Guy Albert d’Amato. Entitled Beethoven Bee-
thovenized, the writer set down his "phrase by phrase" impressions of the work. To Mr. d’Amato, the Symphony represents a complete life-cycle beginning with pre-natal stirrings and ending with the dance of death. Here are a few excerpts:

The first movement opens with a "giant life-thrust, an explosive groan......Again the jolt. Those must be the first fails in an attempt to walk......Then begins the merry pace of childhood......Hoping impatiently, the body and spirit wait to be off. Soon, the mounting spirit in the strings and the in-
creasing tingle of blood, the reeds end in a bursting joyous hail to the sky......The excitement suddenly flags in the bass......Soon they are not the \"internet\" of the flesh; it is the child’s worst enemy......" Had enough?

In a class with d’Amato’s literary ex-
cursions Philip Hale’s review (1941) of the Brahms First. This is what went on in the critic’s mind during the performance: "The music just has to -forest. That arrest is dark......The players wander. They grope as though they were eyeless. Alarmed, they call to each other; frightened, they shout together. Suddenly the players are in a clearing. They see close to them a canal. The water of the canal is green, and diseased purple and yellow plants grow on the banks of the canal......A swan with filthy plumage and twisted neck bobs up and down in the green waters of the canal. And then a boat is dragged towards the players. The boat is crowded with queerly dressed men and women and children, who sing a tune that sounds something like the hymn in Beethoven’s Ninth Symphony......Dark-

ness seizes the scene."

But by way of contrast, here is Robert Bench-
ley’s reaction to a piece of symphonic music. This impression of Weber’s Euryanthe Overture may be found in Chips Off The Old Benchley (Harper & Brothers, 1949): "......Boy, is that kettle-drummer having a good time......Beat their hide off! At-a-
boy! The brasses! Dear old brasses! Say, they certainly know how to blow, those boys. Hot dickyet! It must be fun to have a horn, and, once you are sure of your note, to give it the works like that. You’d have to be pretty sure of your note, though, be-
cause if you put your eyelids and temples and neck-chords into blowing it and it turned out it was the wrong note, you would sound pretty silly......Wait a minute! It sounds like the coda they are going into. The same note twenty-five times usually means they are going into the coda; it’s too bad Benchley never became a part-time music critic.

Two Hokinson-type ladies listening to a Bruckner symphony at Carnegie Hall a couple of years ago were overheard exchang-
ing the following remarks: "You know, I just have to tell all composers they are trying to pull the wool over our eyes......." To which the other replied: "Oh, I agree with you, only I feel that way about all composers."

Of course there are some people who, for one reason or another, find the concert hall an ideal place to snooze.
ADAPTING A RECORD CHANGER
(from page 21)

swing consist of steel phonograph needles of the one-play type fitting into holes punched by a similar needle, preferably one having less taper. This punching operation required much care as the needles are very brittle and tend to break off in the hole. For this reason, soft metal was chosen for the bearing seats; a brass volume control shaft soldered to the steel yoke provides bearing seats for the horizontal swing, while copper tacks driven into the wood arm provide bearing seats for the vertical swing. Three of the bearing needles fit into V grooves cut with a file, and each is held in place by the head of a machine bolt. The fourth bearing needle was set into a hole drilled in the head of the long bolt which also holds the hinge assembly and the three adjusting screws down against the mounting bracket. Figure 5 shows the result.

Mounting the cartridge and making electrical connections was simplified by using part of a plastic replacement changer arm having a plug-in head. The end 3/4 in. of this arm was spliced to a soft pine extension which had been carved to a suitable length and shape. The end of this wood extension was carved to fit inside the plastic arm for the cement and wood screw splice. Figure 7 shows arm mounting dimensions.

The use of a spring-type counter-balance (Figs. 4 and 7) was dictated by lack of space for a longer arm with overhang. Stylus pressure is readily adjusted by means of the spring tension which is varied by the sliding copper pin and locking screw arrangement. A suitable spring was selected by trial from an assortment of radio dial assembly springs.

The lead-in wires are stranded, plastic-covered antenna wire, the most flexible which could be found. For added flexibility, a short length of the wire is coiled at the base of the arm and is wedged in the rubber grommet where it passes through the hinge assembly. These wires are spliced to a shielded phone lead-in cable just under the mounting bracket.
**NEW PRODUCTS**
(from page 34)

- Newcomb FM-AM Tuners. Two new tuners recently introduced by Newcomb Audio Products Corporation, 99-230 Kingsbury St., Dorchester, Mass. 02122. These tuners are designed for use with any high fidelity amplifier equipped with volume and tone controls. FM is detected by a multiplex output jack to permit adaptation for reception of both broadcast and reception of AM radio signals. Response is +2 dB from 20 to 20,000 cps with sensitivity of 5 microvolts for 30-dB quieting. The deluxe "Compact 299" model offers 2-microvolt sensitivity for 30-dB quieting, a new FM detector system with triple limiting action which affords reduced distortion, improved adjacent channel rejection, and exceptionally effective limiting on weak signals. Response is to 20,000 cps within +0.5 dB and distortion is less than 0.2 per cent at 5 volts output. Both models incorporate" A" and "B" Leak circuitry. The "299" also includes a side-tone indicator which is operative on both FM and AM.

- High-Fidelity Three-Speed Tape Recorder. Many high-fidelity features are included in the new Tapesonic Model 70-II tape recorder manufactured by Premier-Electronics, Inc., 93-41 Laffayette St., New York 3, N. Y. Three separate heads permit monitoring at various tape speeds. A front panel A-B switch is provided for comparison between the original and recorded program. A dual-track unit equipped with panel-mounted 4-in. VU meter, the Tapesonic is push-button operated. Control dials include seven electrically interlocked switches and an on/off switch. Those are actually conservative figures. If the growth of our business continues at the present rate, an income of $15,000 the second year is perfectly possible.

- Low-Frequency Filter. Developed essentially for low-frequency applications ranging from 15 to 10,000 cps, the new Allison Model 2-A Filter is needed for a continuously-variable high-pass and low-pass audio-frequency filter for both laboratory and production usage. The equipment has only two controls for each of the filters. One adjusts the slope of the filter in octave steps, while the other is a multiplier. The latter is also a variable. The filter is a passive network which will handle 8 watts in a 600-ohm circuit. Loss is less than 1 per cent at 100,000 cps. Shure 1514 Amplifier, 600-A cartridge, tape, cabinet.

- Employment Register

Positions Wanted and Positions Open are listed here at no charge to industry nor to individuals who are members of the Audio Engineering Society. Positions Wanted listings from non-members are handled at a charge of $1.00, which must accompany the request for insertion. Announcements in this column, brief announcements should be sent to AUDIO, P. O. Box 2625, Mineola, N. Y. before the fifth of the month preceding the date of issue.

- Audio Engineer: 8 yrs. experience in design and product development. Have had complete responsibility of design of amplifiers, preamps, and AM-FM tuners. Presently employed as Chief Engineer for leading hi-fi manufacturer. Would accept responsible position with aggressive organization in components or instrumentation engineering. Send resume and salary requirements to Box 701, Audio.
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