AUDIO ENGINEERING

March
1952
35c

Be Your Own Custom-Builder

see page 24

THE WORLD OF SOUND

They bring true listening enjoyment to millions — through the finest in modern sound recording methods and equipment

RCA Victor's modern Vinylite phonograph records are infinitely superior to the old shellac pressings of a few years ago. Better in tone quality, distortion, surface noise and frequency range. This improvement in quality requires more precision than ever before in every step of record manufacture and processing. That's particularly true of the original sound recording and the master discs from which the stampers are made. And RCA Victor has found that Audiotape and Audiodiscs are an ideal combination to meet the exacting demands for today's high fidelity phonograph records — Audiotape for clearest recording of the original sound and Audiodiscs for fast, easy processing without loss of sound quality. In fact this record-making combination is now being used with outstanding success by America's *leading producers* of fine phonograph records and broadcast transcriptions.

Whatever *your* recording work may be, Audiotape and Audiodiscs offer you this same sound perfection — the result of more than 12 years of specialized experience by the only company in America devoted solely to the manufacture of fine sound recording media, both discs and tape.

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.

Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

...including

audiotape*

for the original sound

... and **audiodiscs***

for the master recording

**Trade Mark*

Successor to RADIO —Established 1917

AUDIO ENGINEERING

INCLUDING VIDEO ENGINEERING

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MARCH, 1952 Vol. 36, No. 3

COVER

The high-fidelity home music system doesn't have to be encumbered by a large and complicated control unit—as indicated by the complete control section of the Bell 2145-A amplifier, described in this month's Equipment Report on page 30. Aside from the phonograph turntable and the radio tuner—which may be located in a convenient closet or bookcase—this small box provides complete control of the amplifier. Photographed in the new sound studio of Hudson Radio and Television Corporation in New York.

RADIO MAGAZINES, INC., 342 MADISON AVE., NEW YORK 17, N. Y.

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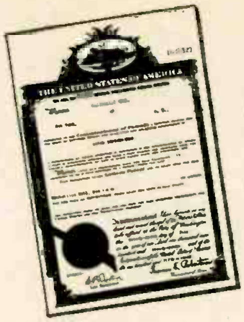


AUDIO PATENTS

RICHARD H. DORF*

ONE OF THE SEVERAL annoying things about the telephone is the fact that to use it you must hold the instrument to your ear. That automatically puts one hand out of business. To overcome the handicap numerous shoulder rests have been devised, each of which requires a different type of contortionism.

How much nicer to have a loudspeaking telephone in a little box like an intercom with no talk-listen switch to operate except at the beginning and end of a call. Ralph K. Potter is the inventor of such a device, covered in patent No. 2,568,823, and assignor of the patent to Bell Telephone Laboratories, Inc. The primary problem with such devices—which if successful would find use in switchless intercom as well as other systems—is acoustic feedback. This has been eliminated in the patent by a novel and ingenious use of a modulated ultrasonic carrier rather than an audio output for the loudspeaker.

Figure 1 is a diagram of the electrical circuit in semi-block form. A microphone mounted in the unit excites a transmitting audio amplifier, the output of which is sent through a standard telephone hybrid transformer to the telephone line. Incoming signals from the line are fed to a receiving audio amplifier. A 30-kc oscillator in the receiving circuit is modulated by the received signals and the modulated 30-kc carrier is emitted by an ultrasonic transducer. The user of the equipment wears in one ear a small, simple, unpowered detector unit which rectifies the 30-kc waves, demodulating them so that he can hear the audio. More on the demodulator later.

The purpose of the hybrid coil in *Fig.* 1 is to prevent excessive transmission of microphone signal to the receiving amplifier and modulator without substantially attenuating transmission of microphone signals to the telephone line or line signals to the receiving circuit. Output from the transmitting amplifier goes to the two primary windings L_3 and L_4. The secondaries L_1, L_2, L_5, and L_6 feed signals to the line and to the balancing resistance, which matches the line resistance. The two secondary signals, as can be seen by tracing the phasing through the two meshes, pass through the receiving amplifier input in opposite phase and if all the elements are balanced they cancel. In practice there is usually a slight unbalance, which permits some signal to pass from the microphone to the modulated oscillator, giving a little desirable sidetone.

The detector worn in the user's ear may take any of several shapes, none of which involves any electrical elements at all. *Figure 2* illustrates one form, a substantially cylindrical metal (nickel silver) shell about 1.25 cm long with an inside radius of about 0.4 cm. The left end has a central opening with a radius of about 0.25 cm, while the right end consists of a slightly dome-shaped metal diaphragm with a curvature radius of about 0.6 cm. Because of the dome shape, any air pressure waves entering the cylinder through the opening at the left end can cause the diaphragm to flex outward (to the right) but rarefactions cannot cause it to flex inward. Thus only half of each ultrasonic pressure wave will be reproduced in a diaphragm motion. When the cylinder is placed in the ear with the diaphragm facing inward, the device effectively rectifies the ultrasonic waves before they reach the ear and the ear recovers the modulation. The ear acts as its own 30-kc filter, of course, since it is insensitive to discrete 30-kc waves. For actual use the detector device is covered with soft felt so that it

[Continued on page 4]

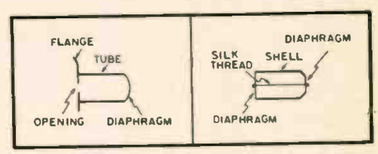


Fig. 2, left; Fig. 3, right.

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

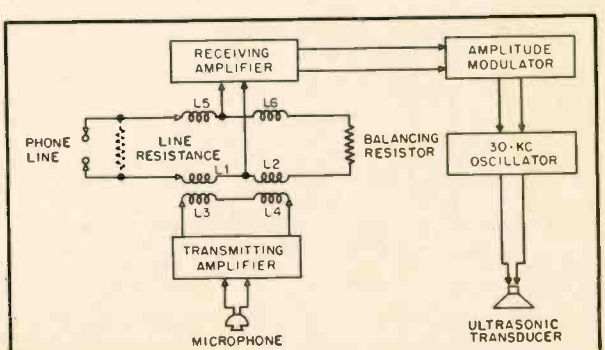
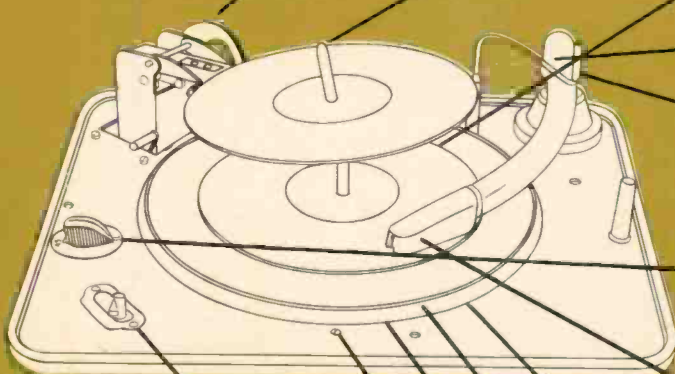


Fig. 1

Model RC-80

GARRARD "Triumph"

THE WORLD'S FINEST RECORD CHANGER



PLAYS ALL 3 SPEEDS —fully automatic with automatic stop.

A triumph of engineering, with every feature tested for finest performance.

GARRARD SALES CORP. Dept. 3 E 164 Duane St., New York 13

Gentlemen:
I am interested in learning more about the Garrard "Triumph" 3-speed record changer. Please tell me, with no obligation, where I can see and hear it in my area.

NAME...
ADDRESS...
CITY....................ZONE.....STATE............

Minimum cabinet space required is 15½" long x 13¼" wide with 5¾" clearance above and 3½" clearance below top of motor board.

PUSHER TYPE PLATFORM:

Adjusts simply to 7"—10"—12" records regardless of diameter or size of spindle hole.

No record changing mechanism has been developed to equal the performance of the precision pusher platform. For records with standard center holes, the pusher platform is the only method that gives positive gentle record operation.

TWO INTERCHANGEABLE SPINDLES:

Easily inserted, the two Garrard spindles accommodate all records as they were made to be played. (If user prefers one spindle can be used throughout simply by plugging center hole of 45 rpm records).

a) Typical Garrard spindle for standard center holes.
b) Easily inserted wide spindle, for 45 rpm records, remains stationary when record is played. Only a small collar revolves, assuring longer center hole and record wear.

HEAVY DRIVE SHAFT:

A unique feature! Exclusive with Garrard!

Drive shaft for 33⅓ rpm and 45 rpm is heavy, thus obtaining more consistent quality at critical low speeds. Wows and wavers eliminated.

BALANCED TONE ARM:

Parallel lift tone arm construction guarantees true tangent tracking. Disturbing resonance eliminated.

AUTOMATIC STOP:

Insures positive and unfailing action at end of any type of record and returns tone arm to rest position.

TRIPLE SPEED SWITCH:

Speed changes are clearly marked, easily made. The RC-80 plays 33⅓, 45 and 78 rpm. Records are placed on the player and simple settings made. Action is then completely automatic, including automatic shut-off after last record of any size.

INTERCHANGEABLE PLUG-IN HEADS:

Carefully engineered to accommodate user's choice of crystal, magnetic or variable reluctance cartridges for standard and microgroove reproduction, such as Astatic, Audak, G.E. Variable Reluctance, Pickering, Garrard Magnetic, etc.

HEAVY DUTY SILENT MOTOR WITH ABSOLUTELY NO RUMBLE:

Speed maintained throughout a wide variation in line voltage. There is no appreciable speed variation operating unit "cold" with a full load, or "hot" with one record, regardless of weight, thickness or diameter of records.

WEIGHTED TURNTABLE:

RC-80 turntable is heavily weighted to give flywheel action. No turntable rumble. No "wows", no wavering reproduction.

MUTING SWITCH:

No sound while changer operates on run-in or run-off grooves. Continuity of music undisturbed by noises.

SIMPLE INSTALLATION:

Mounting holes are identical with former Garrard models, so that replacement is very simple. Unique spring suspension.

CONVENIENT START-STOP-REJECT LEVER:

Start, stop and reject lever are combined and located conveniently away from tone arm.

Changer operates on 100/130 and/or 200/250 volts, 60 cycles, A.C. (50 cycle bushing available.) D.C. model also now available.

fits well and does not cause discomfort because of the cold metal. The flange at the outside end of the unit prevents it from entering the ear canal too deeply.

Figure 3 shows another form of rectifier. A small ear-fitting tube has two diaphragms, one at each end, connected by a light silk thread. The thread is maintained at the right tension so that when the left diaphragm (facing outward) is distended outward by a rarefaction of air it pulls the right diaphragm (facing into the ear) in the same direction. But, when the left diaphragm is pushed inward by a pressure half-cycle, the thread merely slackens and the right diaphragm does not move. The patent shows several other forms as well.

Single-Tube Phase Inverter

Phase inverters have been the subject of much controversy with respect to balance at all frequencies and similar questions, none of which the writer intends to get into, at least at the moment. It does look, however, as though the ingenious new circuit diagrammed in *Fig.* 4 would balance well—and it has the advantage of using only a single tube, yet giving considerable amplification as well as phase inversion. The circuit is the invention of Kurt Enslein, covered by Patent No. 2,571,431, assigned to Stromberg-Carlson.

The 6BN6 gated-beam tube is used in the circuit. In this tube a sharply focused electron beam passes through two control grids, the first and third, each of which has an unusually steep and linear transfer characteristic. Grid No. 2 is an accelerator electrode. Because the total cathode current of the tube is limited to a certain maximum value by the shaped electron beam, the total cathode current remains constant despite changes in the voltage applied to grid No. 1 (or No. 3). Therefore, when the plate current increases the accelerator electrode current decreases, the relative

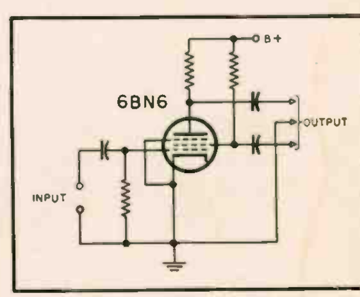


Fig. 4

amounts in each case being determined by the respective transconductances of the control grid to the plate and accelerator. This transconductance has a high positive value with respect to plate and a somewhat smaller negative value with respect to accelerator.

As the diagram of *Fig.* 4 shows, the input signal is fed to grid No. 1 and one output derived from the plate in the usual manner. Since the transconductance of the accelerator is negative (its current varying in opposite phase to that of the plate), a second output may be taken from it; and this accelerator output is in opposite phase to that of the plate, giving, obviously, a phase inverter with outputs 180 deg. apart with respect to ground common point.

To make the two outputs have equal amplitudes, it is only necessary to choose the plate and accelerator resistors so that

[*Continued on page 62*]

TECHNICANA

Magnetic Sound Film in Great Britain

Developments in the field of magnetic sound film in Great Britain are discussed by O. K. Kolb in an article appearing in the November 1950 *J. Soc. Mot. Pict. & Tele. Engrs.* Available in Great Britain are three types of film stock, the differences being in the width coated. The first has a coating for its full width, the second is coated only between sprocket holes, while the third is coated for half its width with magnetic material, the other half being coated with a zinc oxide-lacquer mixture upon which a trace of the sound level or envelope may be made.

A comparison of a medium hard American film, a British film, and a Continental film as to bias, level, and response are presented. The British film requires about half the bias that the American film needs for maximum output, while the Continental film needs almost as much bias as the American film. When a system is adjusted for flat response from the British film and only the record bias adjusted, the American film has 10 db higher output with a rising high-frequency response, while the Continental film is down 2 db from the output of the British product and has a drooping low-frequency response.

Splicing and erasing techniques appear to be similar to those used in the United States with the major exception that in bulk erasing both the film and electromagnet are moved. The film rotates and the magnet is subjected to translatory motion.

The conclusions reached by the author bear out practices here in that it does not appear that magnetic recording will displace photographic recording for the finished prints. However, all the recording up to the final print will be magnetic, with its attendant ease of editing, splicing, and re-use of stock.

Theatre Sound System

The new Simplex XL theatre sound system is described in the May 1951 *J. Soc. Mot. Pict. & Tele. Engrs.* By B. Passman and J. Ward, the article not only describes the equipment, but gives the design philosophy. Important system features include dual exciter lamps on a turret, 20-db preamplifier feedback, low preamplifier distortion, separate preamplifier for nonsynchronous inputs and standby, and a multi-purpose power amplifier.

The nonsynchronous preamplifier has the same changeover features as the sound head pre-amps so that phonograph and line input facilities do not have to be designed and haywired into the system by the installation engineer. Also it provides a spare unit for replacement in the sound head in case of failure of one of the plug-in pre-

[*Continued on page 8*]

Fig. 1

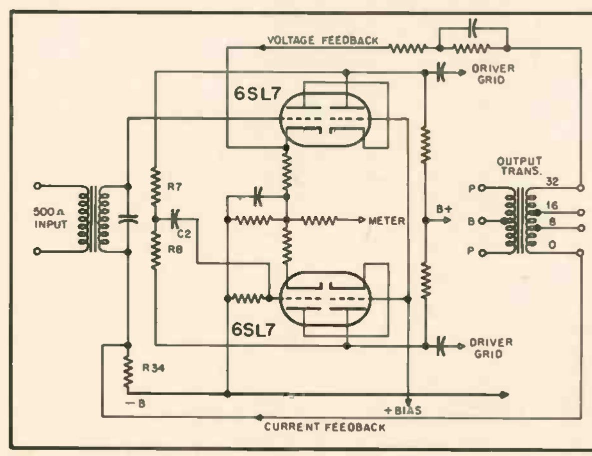


TABLE I

Preferred Maximum Sound Level in db above 10^{-16} watts per cm^2

	Public		Musicians	Program Engineers		Engineers
	Men	Women		Men	Women	
Symphonic Music	78	78	88	90	87	88
Light Music	75	74	79	89	84	84
Dance Music	75	73	79	89	83	84
Speech	71	71	74	84	77	80

THE GATES DYNAMOTE
Here is the latest model GATES DYNAMOTE — as new as next fall's election!

YOU'RE THERE WITH THE Gates "Dynamote"

Some Outstanding DYNAMOTE Features

- Three microphone channels
- Public address take-off with level control
- Cue circuit to studios
- A.C. or battery powered
- Instant — automatic — changeover to batteries if line fails
- High gain — low noise
- Four inch V.U. meter with dimmer control
- Completely self-contained
- Weighs just 31 pounds with batteries installed
- One-piece construction

Whether baseball or politics, symphony or jazz — you can be sure of clean, crisp quality when Dynamoting your "out of studio" shows.

The GATES DYNAMOTE, originated about two decades ago at the advent of the Dynamic microphone, is each year brought up to date as the latest major league standings. — Your 1952 Dynamote is the engineers' choice, the producers' choice and the people's choice — compulsory, of course, because GATES DYNAMOTES are used wherever there is broadcasting.

Heavy political and sports coverage will create unusual demands on remote facilities. Recognizing this, production on the GATES DYNAMOTE has been increased. Orders are being handled same day as received in most cases.

GATES

GATES RADIO COMPANY, QUINCY, ILLINOIS, U.S.A.
MANUFACTURING ENGINEERS SINCE 1922

2700 Polk Avenue, Houston, Texas • Warner Building, Washington, D. C. • International Division, 13 E. 40th St., New York City
Canadian Marconi Company, Montreal, Quebec

amps in the sound head during a run. The power amplifiers are unique in that they make use of cascode floating paraphase phase inverters, and have both voltage and current negative feedback to provide low distortion and stability without reducing the internal impedance of the amplifier. Two sizes of power amplifier are available, one using 807's and delivering 70 watts, and the other a low power unit using 6L6's and capable of handling 20 watts. The output tubes in both cases are driven by cathode followers. *Figure* 1 shows the cascode phase inverter stage. All of the rack- and wall-mounted equipment is designed for ease of maintenance, using either a drawer chassis that pulls out and turns over or doors giving access to terminal boards.

Specially designed loudspeaker systems have been provided to handle theatres of all sizes and for installation in drive-in theatres.

TV Audio Console

A new audio console for television studios is described by Robert W. Byloff in the June 1951 *RCA Review.*

A removable housing is provided at the back of the console to take five ten-inch video monitors, and panels are provided at each end of the console for auxiliary controls and patching. The main console panel has, in the top row, twelve microphone mixer positions each capable of being submastered on one of three color-coded channels, and a VU meter. Above each microphone fader, therefore, is a translucent window. This is lighted with the appropriate color as the fader positions are switched by push button switches located on the left side panel. Also on the front panel, in the lower row, are the three color-coded submaster faders, the studio master fader, remote master fader, and controls for studio playback and reverberation. Six lever keys provide switching for remotes, preview, sound effects filter, and auxiliary circuits.

The left side panel contains four auxiliary microphone faders in a separate mixer circuit, sound effects circuits, monitor controls, and the push buttons for assigning faders to the submaster circuits.

The right side panel includes a jackfield, a dropcord well, microphone equalizer controls, and a switch for selecting either limiting or compression characteristics in the program amplifier.

All the amplifiers, power supplies, relays and an auxiliary jackfield are contained in two separate racks. Placing this equipment in racks enables the size of the console, without the video monitors, to be reduced to 66 in. long, 23 in. deep, and 41 in. high. A desk in front of the sloping face will take legal-size paper without any overhang.

New electrical circuits have been developed for the console to permit the flexibility offered by submastering without excessive losses or change in level with switching. Distortion in the over-all system, at a signal level 10 db above normal program level, is below one half of one per cent while the noise is 77 db below the +10 level. The frequency response is flat from 30 to 15,000 cps.

Automatic Chime Sounder

The January 1951 *A.W.A. Technical Review* (Australia) carries an article by W. A. Colebrook on an automatic unit for sounding the Angelus and other bell sequences.

The unit is operated by a clock mecha-

[*Continued on page 54*]

LETTERS

Speaker and Microphone Directivity

Sir:

It is somewhat alarming to learn how slowly advanced ideas percolate into production practice.

While Dr. Olson's article in the October 1950 issue, with details of the frequency-directional characteristics of a new RCA speaker, is not the first in recent years on such characteristics of sound transducers, this still prevalent source of distortion appears only now to be receiving attention.

In a series of articles in *Radio Broadcast* during 1925, the writer pointed out in detail the distortion introduced in an otherwise perfect sound system, by non-uniform angular pickup and distribution with varying frequency, of the pickup and reproducing devices. Curves on polar co-ordinates were presented for both microphones and speakers from measurements made at the Staten Island laboratory of Wired Radio, Inc. The curves proved beyond doubt that higher and higher frequencies are more and more attenuated if either the sound source or the listener are displaced off the axis of the transducer. When both are so displaced, the separate attenuations are additive. Thus at *no* angular position about a reproducer would the spectral distribution be the same as that of the cone motion of a loudspeaker, even though it followed an otherwise perfect system.

A visual analogue consists of a white light source having in front of it an optical device which projects the shortest-wavelength (violet) radiations strongly through a small cone on its axis, and which projects the longer waves (blue, through green, yellow, orange, and red) waves in ever widening solid angles beyond the speaker axis. As with the speaker, there is no point in the light radiation field where one can find the white light of the source behind the optical device.

Over-all sound-to-sound measurements of a system are therefore worthless unless both microphone and loudspeaker are designed so as to have uniform directional characteristics throughout the required audio spectrum of frequencies. Also, the frequency-characteristic curves of microphones and loudspeakers should always be accompanied by frequency-directional curves if they are not to be all but meaningless.

B. F. Miessner,
Van Beuren Road, R.F.D. 2
Morristown, N. J.

Another New Field?

Sir:

I suggest that Æ expand its primary field of interest and coverage beyond the limits of the audio spectrum. I suggest it might well cover the whole spectrum of sensory and motor response and control. This field would include the whole field of intelligence or data transmission, probably extending from d.c. to 10 mc/sec. Thus it would include all forms of intelligence usefully capable of modulating a carrier, including servo, computer, radar, audio, video, photographic, telemetering, remote control, cryptographic, and other miscellaneous types of data sensing, recording, transmitting, measuring, indicating, and reproducing systems.

[*Continued on page 65*]

EDITOR'S REPORT

COMPONENTS

RECENT DISCUSSIONS regarding the components selected by those of us who like to "build our own" test equipment, amplifiers, power supplies, and other electronic apparatus brings to light some interesting facts which have rarely been mentioned in technical literature from the viewpoint of the constructor.

In building equipment for commercial sale—such as mass produced radio and TV sets, for example—the element of cost is of primary importance. The price of a tube socket or a resistor is usually measured in cents at the manufacturing level, but that figure is multiplied by a factor of around five when the finished product appears at the consumer level. Thus if a TV set with 150 resistors should be built with a higher quality part costing only one cent more than the competitive grade, this difference alone makes the selling price of the set some seven and a half dollars greater than if the low-priced part were used. As another example, it has often been said that Lock-in tubes never attained their deserved popularity because their sockets cost three-tenths of a cent more than the simpler-to-make octal.

In the construction of amplifiers or test equipment on a one-of-a-kind basis, or even for those hand-built units often assembled by the custom-builder, the few extra cents—or even dollars—are not of so great importance. When we consider that the average home- or shop-built amplifier involves a cost measured in dollars for the equipment, and probably in tens of dollars for the labor of building and testing, it seems desirable that we take a closer view of the economic advantage obtained by the use of the minimum-priced components. Not that we begrudge the labor—we'd be the last to suggest that the labor cost be taken into account for such equipment as we construct for our own use—but the fact remains that it is actually a factor in the over-all cost of the finished product. Therefore, when we do use a cheaper component, we are risking the performance of the unit for a small percentage of saving, and it is doubtful if this is an intelligent practice.

Many constructors are prone to use half-watt resistors throughout a circuit, unless the current requirements completely preclude it. We believe that any resistor which carries direct current—with the possible exception of a cathode resistor which is usually bypassed, and usually of low resistance value—should be at least of a one-watt rating. In any case, the resistor should be specified to work with a factor of safety of the order of four—one which dissipates 0.23 watts should preferably be a one-watt unit, and so on. The same reasoning applies to the selection of tube sockets, selector switches, coupling and bypass capacitors, wire, cable-plugs and receptacles, and any other component for which there is a high-rated equivalent.

This practice is followed rigorously by manufacturers of equipment for the military services, and for high-quality home construction it is strongly recommended.

MAGNETIC TAPE DIMENSIONS

We have recently had an experience with the dimensions of magnetic tape which led us into an interesting inquiry. In the preparation of our weekly "Audio Time" over WABF (New York), we encountered one box of tape which didn't fit the tape splicer as easily as previous rolls, and in one instance, the tape would bind in the recorder guides.

Mention of this to the manufacturer resulted in his making complete measurements on the tape, which proved to be within the allowable tolerance for width—not greater than 0.250 in. and not less than 0.244 in. This particular roll measured 0.2485. In the discussion of this problem, we learned that some manufacturers started making tape within the allowable limits, then—because tape heads develop a groove from continued passage of tape—the width was gradually decreased in small steps so that continued good performance could be obtained with succeeding shipments of tape.

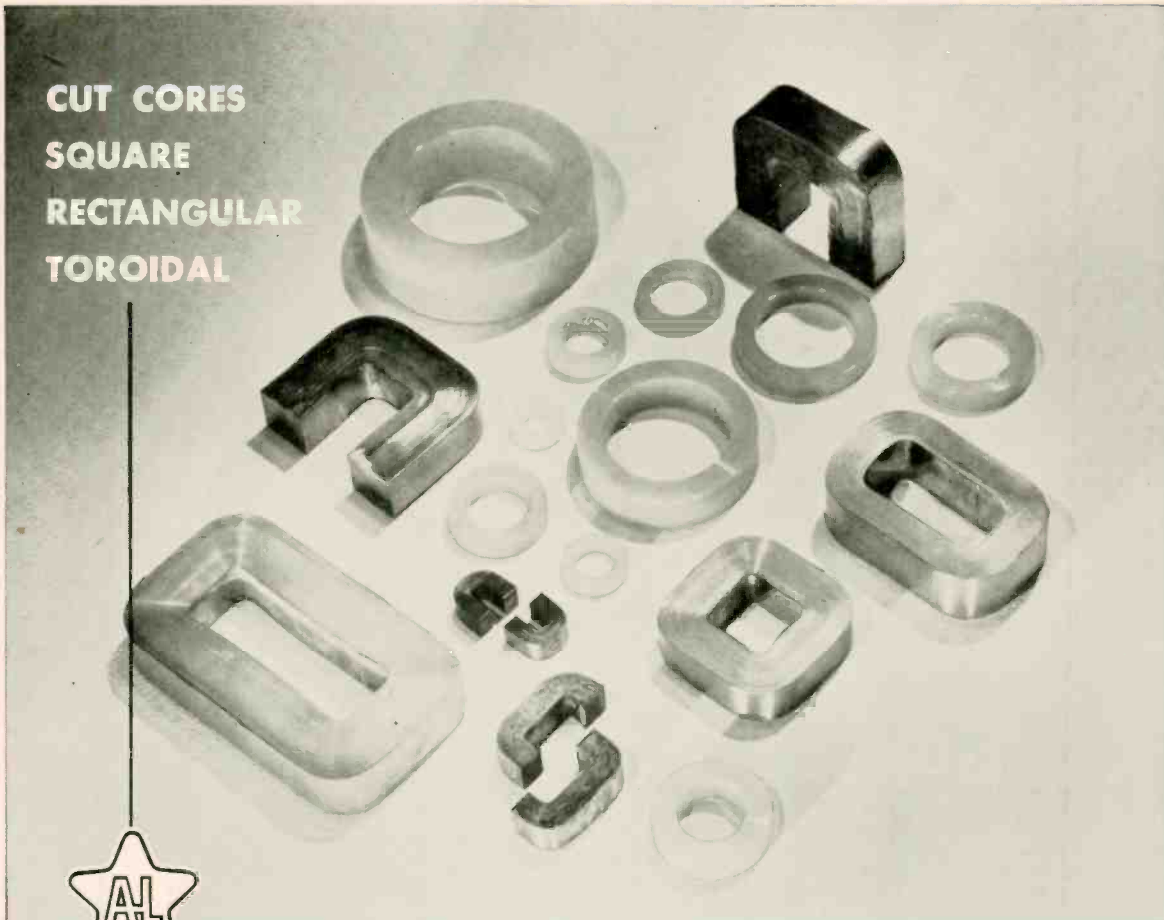
All of which brings us to the point of this story. As tape heads wear, performance of the machine may be degraded—slightly, perhaps, but measurably. Honing may be resorted to in order to restore the performance to normal, and in professional applications it would be desirable that monthly maintenance checks should include some means of determining if the grooves which wear gradually are contributing to a loss of highs to an objectionable degree.

CONGRATULATIONS

The good-music listener gets little enough to keep him happy from the programming of most radio stations these days, so the recent addition of WNBC (New York) to the ranks of all-night stations six nights a week is received with open arms. Broadcasting on both AM and FM, NBC's flagship is now bringing all types of good music from midnight to six. We may not be the first to congratulate WNBC in print, but Æ's readers in the New York area will undoubtedly be among those who derive the greatest pleasure from "Music Through the Night."

So far, New Yorkers have been fortunate in having the city-owned station WNYC on the air on FM until three, with classical music. We are unable to figure out why all three of the "good-music" stations in this area—WQXR, WNYC, and WABF—all elect to play chamber music from eleven until midnight. Such a lack of originality in programming is surprising in this day of strong competition. Please, couldn't *one* of them deviate from this standardization?

While we are at it, we should also congratulate CFRB of Toronto on its 25th anniversary, celebrated on February 19. Unique in that it was the first "batteryless" station, CFBR went on the air in 1927, pouring music into the airways with power and clarity that was revolutionary in those days. The power on the opening night was 1000 watts—it is now 50,000. Again we say, "Congratulations, CFBR."



Anything You May Need in TAPE-WOUND CORES

RANGE OF MATERIALS

Depending upon the specific properties required by the application, Arnold Tape-Wound Cores are available made of DELTAMAX . . . 4-79 MO-PERMALLOY . . . SUPERMALLOY . . . MUMETAL . . . 4750 ELECTRICAL METAL . . . or SELECTRON (grain-oriented silicon steel).

RANGE OF SIZES

Practically any size Tape-Wound Core can be supplied, from a fraction of a gram to several hundred pounds in weight. Toroidal cores are available in fifteen standard sizes with protective nylon cases. Special sizes of toroidal cores—and all cut cores, square or rectangular cores—are manufactured to meet your individual requirements.

RANGE OF TYPES

In each of the magnetic materials named, Arnold Tape-Wound Cores are produced in the following standard tape thicknesses: .012″, .008″, .004″, .002″, .001″, .0005″, or .00025″, as required.

Applications

MAGNETIC AMPLIFIERS
PULSE TRANSFORMERS
CURRENT TRANSFORMERS
WIDE-BAND TRANSFORMERS
NON-LINEAR RETARD COILS
PEAKING STRIPS . . . REACTORS.

W&D 3963

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION
General Office & Plant: Marengo, Illinois

AUDIANA

How Good is an Audio Transformer

WHILE THE USE of audio transformers in a modern home-music-system amplifier is generally restricted to the one between the output stage and the loudspeaker, the consideration of the quality of this important component must take into account all of the general characteristics of transformers as a class.

In order to study the effect of various parameters of the design and construction of a transformer—or of practically any other unit of electronic equipment or transducers (pickups, speakers, microphones, etc.)—engineers make use of equivalent circuits. By this means, the performance characteristics can be determined with a fair degree of accuracy throughout the entire audio spectrum, and corrections may be applied to improve the product.

Equivalent circuits for transformers usually ignore the step-up or step-down ratio of the winding, with the assumption that this job is done perfectly—which is practically the case. Thus it is possible to draw a circuit which has all of the characteristics of a transformer except that of voltage raising or lowering, and to assume that the output voltage is equal to the input voltage, modified by the characteristics of the transformer itself, multiplied by the step-up or step-down ratio of the number of turns. In doing this, all of the qualities of the secondary winding are "referred" to the primary.

If a capacitor of a certain value is connected across the primary of a transformer, it will have a given effect upon the performance. If the same capacitor is connected across the secondary, its effect will be multiplied by the impedance ratio of the windings—the impedance ratio being the square of the turns ratio. In a similar manner, all of the characteristics of the secondary may be referred to the primary for ease in making the calculations. This referral is much like converting dimensions into the same terms—if we are speaking of two packages on a comparative basis, we do not say that one weighs sixteen ounces and the other weighs two pounds, but instead, we say that one weighs sixteen ounces and the other thirty-two, so that the weights can be compared readily.

The important characteristics of a transformer are: core loss, which means the energy consumed in magnetizing and demagnetizing the core with each cycle; winding resistance, or the losses due to the actual resistance of the copper wire making up the windings; interwinding capacitance, or the effect of capacitance between adjacent layers of the primary and secondary windings; capacitance to ground or core, which affects high-frequency performance; and leakage reactance, which is a factor based on the degree of coupling between the two windings—in effect, a measure of the lack of perfection in transformer action.

While the performance of a transformer may be considered perfect (almost) at mid-frequencies, the performance at the high and low frequencies is what makes the important difference between a good unit and a poor one. In order to have good low-frequency response, the primary must have a high value of inductance. This is likely to increase winding resistance appreciably, and so makes a large transformer necessary. A high step-up ratio makes a greater number of turns on the secondary, with greater capacitance to ground, which reduces high-frequency response unless exceptional care is taken in the construction. And, unless windings are interleaved, it is probable that the leakage inductance will be high, also affecting high-frequency response adversely. Leakage inductance appears as a series inductance in the secondary circuit—having little effect upon lows but decreasing the highs appreciably.

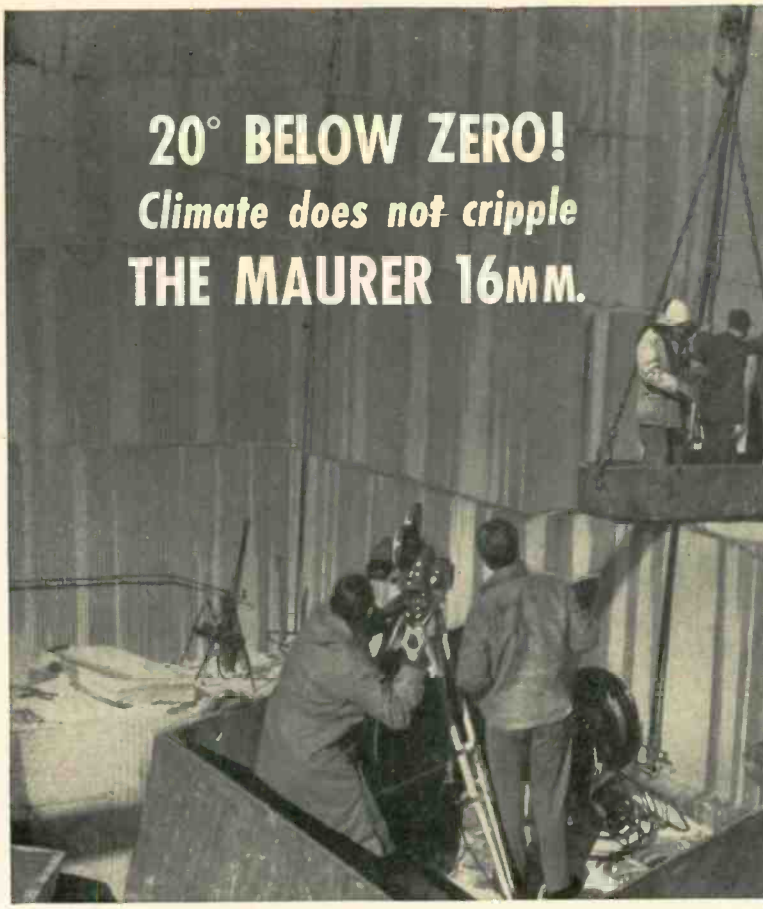
This article is the first of a series of three which will deal with transformers, and particularly with their uses in audio applications, since power transformers have fewer problems of design—mainly because they work at only one frequency.

Pickup Tracking Error

Phonograph performance is affected by a large number of factors—not the least of which is the imperfect position of the stylus with respect to the groove. Almost without exception, phonograph records are cut by a stylus which moves laterally along a radius of the disc, thus remaining perfectly tangent to the groove at all times. However, in practically no instance does the pickup move along the same radial line, but instead it moves along the arc of a circle which is planned to lie as close to a radius as possible. If the pickup arm were infinite in length, the stylus would follow a straight line, but this is certainly not practical for the average phonograph. Several patents have been issued over the past twenty years or so on devices which would cause the pickup to track on a straight line, but most of these involved highly complicated structures which would undoubtedly introduce more troubles than the one they would cure.

An inspection of the geometry of the pickup will show that when a straight arm is used the axis of the arm is not tangent to the groove at more than one place, and

[*Continued on page 49*]



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Pickup Tracking Error

EDGAR M. VILLCHUR*

Misconceptions on the subject of tracking error are many, and recent articles have been sparse. The author presents a lucid analysis of tracking error and its effects upon distortion in phonograph reproduction.

The problem of keeping a phonograph pickup tangent to the record grooves at different radii has been with us ever since manufacturers abandoned the cylinder player, a device in which the pivot of the overhead pickup was driven across the record by a feed screw. With disc records, tracking error constitutes a problem, and the reasons for it and the principles involved in its solution are here discussed.

Some years ago the most serious effect of tracking error was considered to be undue wear of the record. The tip of a steel needle loses its spherical shape after a few revolutions of the turntable and is ground to the form of a wedge, with its long axis lying along the groove. If the pickup then turns with respect to the groove due to change of tracking angle the needle tip is re-ground and abrasion of the groove walls is increased. There has been some disagreement as to the extent of this increase, but in any case a jewel stylus maintains its shape better, and turning the spherical tip in the groove does less harm. Record wear is therefore a minor matter in tracking considerations when jewel styli are used. Tone arm design even makes a degree of sacrifice in this direction (side thrust is allowed to increase) for the sake of other benefits.

The main result of tracking error in modern equipment is that the vibration axis of the pickup is turned from the groove, generating distortion. If the line from stylus to arm pivot is at an angle to the groove tangent, the stylus is also pressed against one groove wall more than the other. Extreme angles will cause an increase in record wear and in the chances of groove jumping. None of these effects was very noticeable on older phonographs because pickups were quite heavy and tracking distortion was relatively small compared to other types of distortion.

Side Thrust

Figure 1 shows the forces acting on the stylus under two conditions of tracking error. The stylus at rest is subject only to the weight of the pickup and support of the groove, and will always be seated correctly, no matter what the tracking angle. When the groove is moved past the stylus, however, the tip is subjected to two additional forces equal to each other in magnitude, the frictional force F_G of the groove which tries to drag the stylus with it in a tangential direction, and the force resisting F_G in a direction toward the pivot, shown as F_A. When the frictional pull of the groove and the resistance of the arm do not lie along the same line, a resultant side force is exerted on the stylus independent of groove modulation, either towards the center of the record, as at (A) in *Fig.* 1, or away from the center, as at (B). The slope of the groove walls directs some of this force upward, and so if pressure against the sidewall is great enough the stylus will climb towards and possibly over the top of the wall.

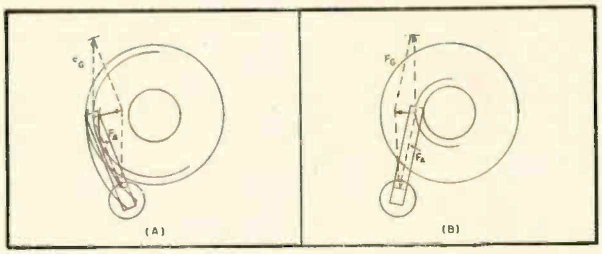

Fig. 1. Force components of side thrust on stylus.

The force resisting frictional drag of the groove is applied along the straight line from arm pivot to stylus, coupled from the pivot by means of the arm. Since the arm is rigid the direction of the line of force is formed by the stylus and pivot independent of the particular shape of the arm. The tendency of the stylus to ride up on the walls of the groove cannot, therefore, be made less by the use of a bent arm.

Contrary to occasional popular opinion this tendency is actually somewhat greater in offset arms, not because of their shape but because of the way in which they must be mounted. The imaginary line connecting the pivot and stylus of an offset arm makes a larger angle with the groove tangent than the corresponding line of a properly mounted straight arm. The greater the angle of offset the worse the offending nature of the pivot location in this respect, and the more the side thrust on the stylus. This is one of the reasons that studio-type offset arms are long, requiring only a small angle, even though an eight-inch arm with a larger angle may be designed to have almost negligible tracking error. The increased side thrust of bent arms is accepted as a far lesser evil than tracking error. Since the side thrust of bent arms is always directed toward the center of the record, a moderate amount serves to overcome frictional resistance of the arm pivot.

Tracking Error Distortion

It is evident that an arm which maintains tangency well due to its offset design may actually produce more side thrust than an arm with greater tracking error, and distortion generated by non-tangency cannot be laid primarily at the door of improper seating of the stylus in the groove. Even if the arm holds the pickup at an angle to the groove tangent, the stylus may follow the groove convolutions without error. Stylus motion in an oblique, pickup however, will not be perpendicular to the groove, and instantaneous stylus displacement relative to the longitudinal axis of the pickup will not correspond to the recorded signal. *Figure* 2 shows consecutive positions of styli in two identically modulated grooves. In (A) there is no tracking error. Displacement of the stylus relative to the pickup, plotted against time, is a copy of the groove's wave form. In (B), with the stylus tip still following the groove, a tracking error of α results in a distorted shape of the same graph. As can be seen, maximum stylus displacement relative to the center line of the pickup occurs first too soon and then too late within the recorded period. Maximum stylus displacement across the pickup is also greater in amplitude than maximum displacement relative to the center line of the groove.

This effect is aggravated when groove modulations are heavier or closer together. The distortion generated is therefore inversely proportional to groove radius and turntable r.p.m., and directly proportional to the amplitude and frequency of the recorded sound.

Another source of possible tracking

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distortion is the offset angle of the cartridge in bent arms[1]. The force trying to carry the stylus away from the arm pivot tends to turn a swivel-type stylus assembly to face the pivot. But the cartridge held by a bent arm cannot, by the nature of its mounting, ever face the pivot. Thus the lateral position of the stylus following an unmodulated groove is not along the center line of the cartridge, and the stylus at lateral rest is not at the center of its normal play. *Figure* 3 illustrates this angular bias in a pickup and in an analogous system made up of two linked rods.

The amount of bias is directly proportional to the compliance of the coupling between stylus and pickup and to the angle of offset of the cartridge. It will become significant only if the moving element of the cartridge is driven into a non-linear region of operation, in which case asymmetrical or even-harmonic distortion is generated. It is far less consequence than the first type of tracking distortion, or offset arm design would offer no advantage, but it constitutes a second reason for making offset arms as long as possible and with a small angle.

Arm Design and Mounting

The approximate solution to the tracking problem is to use a tone arm as long as can be afforded, to locate the pivot in that position which produces the least variation of angle between arm and groove (ignoring the absolute values of the angles) and to then offset the pickup from the arm to bring the center line of the cartridge or element to tangency with the grooves at selected radii. The most popular misconception about the offset arm is the belief that it is the bend in the arm which produces the reduction in tracking angle variation, due to a "virtual pivot" or other fancied cause. The variation in groove-pickup angle for any arm of given length, mounted at a specified point, must be the same whether the arm is straight, bent, or shaped like one of the snakes of an ancient Egyptian head-dress. This becomes clear if we think of a bent arm forming a rigid triangle with the line from pivot to stylus. The angle between this line and grooves of different radii, representing the tracking of a straight arm, must vary exactly the same amount as the angle between the grooves and the offset pickup. Improvement in tracking can only result from the shift in pivot mounting which the offset allows us to make.

It is possible to choose a mounting point for a given arm such that the arc swept across the record intersects the grooves with minimum variation of angle. *Figure* 4 shows the arcs produced by the same arm from different pivots. Considering only the variation in angle at which the arc encounters each groove it will be seen that arc 3 has the best tracking. The graph of tracking angle versus radius indicates that arcs 1 and 2 decrease their angles of intersection with each groove as they approach the center, while arc 3, representing a position of the pivot which "overhangs" the stylus past the turntable spindle, decreases its intersecting angle only up to a minimum point and then increases the angle again as further progress toward the center is made. The fact that the intersecting angle goes through a minimum point means that for some angle values before the minimum there will be an equal value after the minimum.

It would not be feasible to mount a straight arm to sweep arc 3, because although the variation in angle is small the actual angle at which the pickup would be held is far from the tangent. A positional bias is therefore applied to the pickup element by offsetting it β. We have already seen that the variation in intersecting angle is independent of arm shape, and so we will not lose the advantage of minimum variation by this offset, while we gain correction by this method for the absolute value about which the tracking angle varies.

[1] G. A. Briggs, *Sound Reproduction*, 2nd ed., Wharfedale Wireless Works, Bradford, Yorks. Quote on page 206 from a paper by W. J. Lloyd.

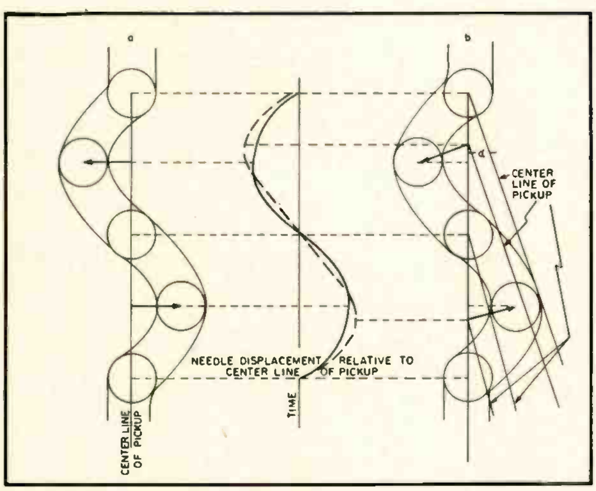


Fig. 2. Distortion caused by tracking error arrows indicate maximum stylus displacement relative to pickup.

Zero tracking error may be achieved at two points: at the groove for which the offset makes a perfect correction, and at its mate on the other side of minimum. The points of zero tracking error (determined by the angle of offset) and the groove radius at which the minimum intersection angle occurs (determined by the pivot mounting) are adjusted for optimum performance. These adjustments are concerned with keeping $\frac{\alpha}{r}$ rather than α alone as small as possible.

Tracking Equations

The tracking equations of most interest are those which furnish information on optimum offset angle, correct pivot mounting for a given arm, and the tracking error and distortion of a given system. B. B. Bauer[2] has derived general forms of some of the foregoing equations in a clear and interesting article to which the reader is referred. The equations below apply only to twelve-inch records, and have had small decimals of no significance dropped.

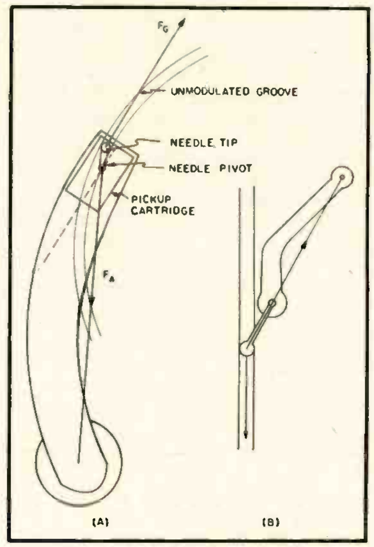


Fig. 3. (A) Pickup bias due to cartridge offset, and (B) analogous mechanical system illustrating pickup bias.

Optimum offset angle β for an arm of length l inches (pivot to stylus tip) is:

$$\beta = \frac{179}{l} \text{ degrees}$$

The overhang D (the distance from spindle to stylus) of such an arm, or of an arm with a larger angle of offset (some designs have considered minimum tracking error without reference

[2] B. B. Bauer, "Tracking angle in phonograph pickups," *Electronics*, March 1945, p. 110.

to the need for better tracking at the inner grooves) should be:

$$D = .9\left[\frac{\beta}{57.3} - \frac{1.8}{l}\right]\left[\sqrt{1 + \frac{(\beta/57.3)^2}{(\beta/57.3 - 1.8/l)^2}} + 1\right] \text{ inches}$$

and when β is equal to the optimum $\left[\frac{179}{l}\right]$ deg., the expression simplifies to:

$$D = 4.2/l$$

The equations for D are inaccurate for arms whose angle of offset is less than the optimum β. For arms in which

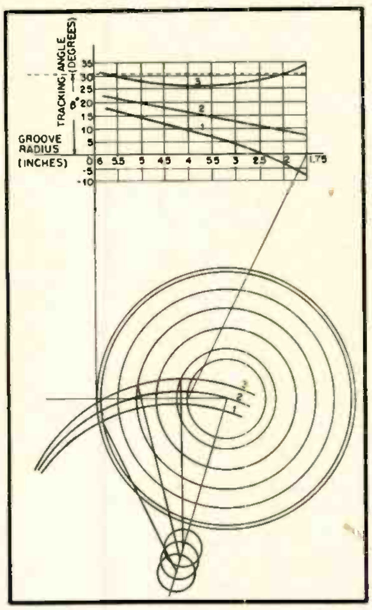


Fig. 4. Tracking angle variation of the same arm at different pivot mountings.[3]

β is between 2/3 of optimum and optimum we must change the expression to:

$$D = 2.9\left[\frac{5.8}{l} - \frac{\beta}{57.3}\right]\left[\sqrt{1 + \frac{(\beta/57.3)^2}{(5.8/l - \beta/57.3)^2}} - 1\right]$$

And for arms whose offset angle is less than 2/3 of optimum we use:

$$D = \frac{.013\beta - \frac{1}{l}}{.36}$$

The equation for a straight arm, with β equal to zero, becomes:

$$D = -\frac{1}{.36\,l}$$

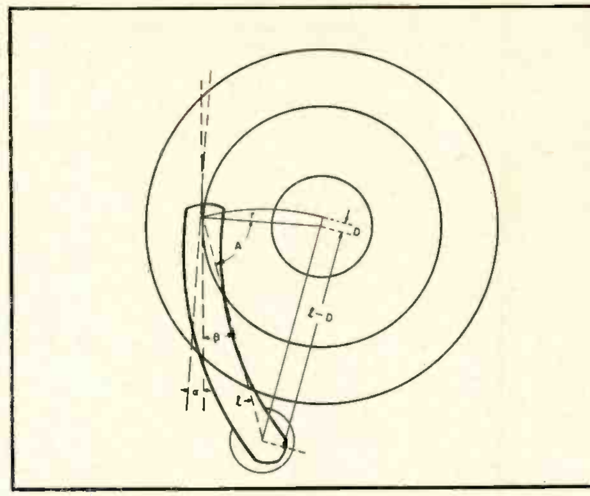


Fig. 5. Basic oblique triangle used in determining tracking characteristics.

As would be expected from the tracking curves of *Fig.* 4 optimum mounting of the straight arm requires that the needle be underhung by an amount which places the point of perfect tracking at the inner grooves.

The tracking error α of a given system at a groove of radius r is equal to:

$$\alpha = \sin^{-1}\left[\frac{r^2 + 2\,l\,D - D^2}{2lr}\right] - \beta$$

The derivation is simple and interesting enough to be included in the appendix. Maximum α over the record may be found by checking at the three radius values at which maximum error could occur: the inner groove, the outer groove, and the groove at which the angle of intersection with the arc of the tone arm reaches a minimum and begins to increase again. Tracking error at the first two points is found by using 1.75 inches and 5.75 inches, respectively, for the value of r. The radius at the third point can be solved for after setting the partial derivative $\frac{\partial \alpha}{\partial r}$ equal to zero, and is equal to:

$$r_s = \sqrt{D(2l - D)}$$

The main tracking distortion is second harmonic. On a basis of stylus velocity change, the per cent distortion is:

$$H = \left[\frac{1.05\,f A \alpha}{V r} \times 100\right] \text{ per cent}$$

where f = frequency of the signal in cps
A = amplitude of maximum groove modulation in inches (.004 inches at 250 cps would be typical of 78 r.p.m. commercial records containing loud passages.)
α = tracking error in degrees
V = r.p.m. of turntable
r = radius of groove

The tracking distortion produced in a standard commercial pressing by a properly mounted 8-inch straight arm (17-deg. maximum error at the outer grooves, 8-deg. maximum at the inner) may be expected to be of the order of 6 per cent on loud passages. A correctly designed offset tone arm of the same length will reduce the tracking error and the distortion by a factor of six.

APPENDIX

From the trigonometric formula for oblique triangles (see *Fig.* 5):

$$(l - D)^2 = l^2 + r^2 - 2\,l\,r\cos A$$

$$\angle A = \cos^{-1}\left[\frac{r^2 + 2\,l\,D - D^2}{2\,l\,r}\right]$$

$$\angle A + \angle\beta \pm \angle\alpha = 90°$$

$$\alpha = (90° - A) - \beta$$

$$\alpha = \sin^{-1}\left[\frac{r^2 + 2\,l\,D - D^2}{2\,l\,r}\right] - \beta$$

The ability of a pickup and tone arm to maintain good stylus-groove contact is often referred to as tracking capability, and the weight required to keep the stylus properly seated is called tracking pressure. These expressions would seem to have something to do with pickup tangency, but they do not. Stylus seating at normal tracking errors is almost independent of tangency. The term "tracking" is used in two different ways in relation to tone arms: it has a literal meaning which relates to seating of the stylus in the track of the groove; and a technical or mathematical one, which refers to maintenance of a constant tangency relationship between two variables, the pickup axis and the groove at the point of stylus contact. In the latter application the word is used in the same way as when it describes the behavior of one section of a variable capacitor, which "tracks" or keeps a constant capacitance relationship to another section with which it is ganged.

[3] Values from Ralph P. Glover, "A record saving pickup," *Electronics* Feb. 1937, p. 31.

How Good is an Audio Transformer?

N. H. CROWHURST*

A thorough understanding of transformers is essential to the selection of the proper type for any particular application. The fundamentals are here presented by the author to introduce the series on one of the most important components in high-quality audio equipment.

THERE WAS A TIME when audio transformers were specified simply by turns ratio. An interstage transformer would be designated, according to ratio, e.g., 3:1 or 5:1. But one component would give much better performance, although having the same turns ratio as another. The modern transformer manufacturer knows that there is far more to designing a good transformer than just putting windings on a core so as to have the correct turns ratio. Each design must in fact be suited for the particular job in hand. To help the prospective user, the component is generally specified by the circuit for which it is intended, e.g. "10,000-ohm plate to single grid," together with some statement of frequency range. This is much more informative, but a still further and more detailed understanding of audio transformers will enable them to be used to best advantage in every application.

Any audio transformer is essentially a matching device, but no transformer is a perfect matching device because it introduces its own losses and defects. It is the designer's job to see that these losses and defects are kept to suitable proportions. If he has done a good job, then the user can get the best performance from the component by following the manufacturer's recommendations as to circuit values. But it would not be economic to design a different transformer to suit every possible application or circuit, so a standardized design often has to cover a range of uses. A perfectly good transformer, connected into a circuit unsuited for it, will give poor results, but correct understanding of the problem can help rectify these deficiencies.

How Big Must it Be?

A popular fallacy has been that audio transformers always follow the principle "the bigger the better." Sometimes size is essential to quality, but for other applications the smaller component is the better one.

All modern transformer core materials have a well defined saturation density. Magnetization above it will considerably distort the current waveform, and the distortion will reflect into the circuit. The saturation density will correspond to different voltage levels at different frequencies, so the handling capacity of a transformer depends on the frequency considered. A winding that will accept 5 volts at 60 cps before distorting will accept 10 volts at 120 cps.

Applying this fact to audio power transformers, a component rated to deliver 10 watts over a frequency range down to 60 cps will deliver considerably more power if the low-frequency cut-off is raised to, say, 240 cps. Conversely, a smaller transformer may be used for the same power rating if a higher cut-off is employed. In practice, the fact that only signals of low level are needed at the low-frequency end of the audio spectrum enables smaller transformers to be employed than would be possible if full output were required down to, say, 60 cps.

Another factor that affects size is the presence or otherwise of d.c. polarizing. Where plate current passes through one winding (not in push-pull), the core becomes polarized. To minimize this polarization, a gap is left in the core by the manufacturer, according to the intended current. Polarization reduces the allowable a.c. magnetization, but the gap in the core reduces the primary inductance unless the turns are increased. So to achieve suitable primary inductance and satisfactory a.c. magnetization limits, without excessive insertion loss, the presence of polarizing current requires more turns on a larger core size.

For input transformers—line to grid, or microphone to grid—size is seldom an advantage, the best transformers designed being of small size. For interstage transformers, where appreciable voltage swing is required, a slightly larger transformer may be necessary. For driver transformers, where power must be delivered to the grid circuit, considerably larger sizes are required.

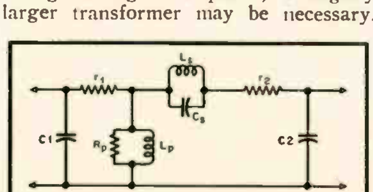


Fig. 1. Equivalent circuit of audio transformer.
C_1 = primary capacitance; C_2 = secondary capacitance; C_3 = interwinding capacitance; L_p = primary inductance; L_s = leakage inductance; r_1 = primary resistance; r_2 = secondary resistance; R_p = core loss referred to primary

Its Electrical Specification

The transformer's electrical properties have a direct bearing on its performance, but the user will not necessarily be bothered with them directly. His concern is with the performance of the finished article. The principal properties are shown for reference at *Fig.* 1, which will assist in understanding the behavior of the transformer under different conditions, and what part each contributes. This is one way of representing the equivalent circuit of any audio transformer. For convenience, the fact that the transformer provides a step-up or step-down is not shown in the diagram. This action of the transformer may be regarded as perfect, its imperfections being presented in the circuit values of *Fig.* 1. The legend under the diagram explains what each symbol represents.

There are four elements shown as shunting the transmitted signal—primary and secondary winding capacitance, primary inductance, and core loss referred to the primary.

There are four elements shown as in series with signal transmission—primary and secondary winding resistance,

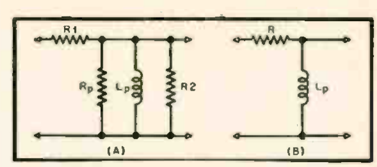


Fig. 2. Equivalent circuit for low-frequency cut-off, in a direct-coupled a.f. transformer. (A) Complete arrangement: R_1 = primary source impedance; R_2 = secondary load impedance. **(B) Simplified equivalent of (A):** R = parallel combination of R_1, R_p, and R_2.

leakage inductance, and interwinding capacitance.

All these circuit elements must be referred to one winding when considering their effect. If the primary is the chosen reference winding, then elements actually due to the secondary winding or its associated circuit must be "referred" in value by a factor of the turns ratio squared. Suppose the ratio is 3:1 step-up, then secondary winding resistance is divided by 9 and its capacitance

* *82, Canterbury Grove, London, S.E. 27, England.*

multiplied by 9 in referring to the primary. Usually the "referred" winding resistances of both windings are of the same order, but the referred winding capacitance of the high winding is much larger than that of the low one (about 9 times for 3:1 ratio). Hence the effect of the low-winding capacitance can often be ignored, only that of the high one being taken into account.

Insertion Loss

At a middle frequency, the shunt reactances will be high enough to exercise negligible effect, while the series reactance of L_s will be low enough to ignore, so the transformer is virtually a "T" resistor network, the attenuation of which can be calculated with reference to external circuit values—also usually resistances only—at mid-frequency. This attenuation, essentially a measure of power loss, is known as the insertion loss of the transformer.

For input and interstage transformers, where voltage transfer is the important feature, insertion loss is not generally given serious consideration. But for driver and output transformers, where insertion loss means valuable watts are lost, it must be considered. Insertion loss may be expressed in db, when the fractional power ratio corresponding to the db figure gives the proportion of input power reaching the output, or it may be expressed directly as a percentage. For example an insertion loss of 1 db represents an efficiency of approximately 80 per cent.

For a given transformer size, correctly designed, the ratio of r_1 and r_2 to R_p is fixed by the geometry of the component. Variation of turns and wire

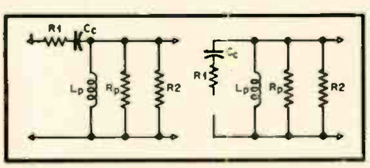


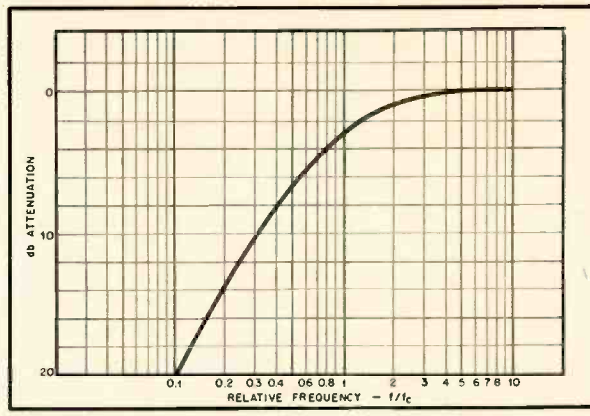
Fig. 4 (left). Equivalent circuit for low-frequency cut-off in a parallel-fed a.f. transformer: C_c = coupling capacitor. Fig. 5 (right). Rearrangement of Fig. 4 to show it as a resonant circuit.

gauge to suit, varies winding resistance and referred core-loss shunt in the same proportion. Thus a winding with too few turns results in low core-loss shunt, while too many turns produces excessive winding resistance. Conversely, from the user's viewpoint, connecting a transformer to circuits of lower impedance than design values introduces high series loss due to winding resistance, while connection to higher impedances results in serious shunt losses due to core magnetization.

In generally, a variation of impedance results in a deficiency in frequency response as well, and the choice of the number of turns in design must be a compromise to achieve good response to both low and high ends of the spectrum.

At low frequencies, the effect of L_s, C_s, C_1, and C_2 is negligible, but that of

Fig. 3. Low-frequency cut-off attenuation characteristic, 6 db per octave.



inductance L_p will become appreciable. For the purpose of comparative response, the values of winding resistances r_1 and r_2 can generally be ignored as small compared to the circuit resistances R_1 and R_2 to which the transformer is connected. Thus the circuit can be redrawn as at *Fig. 2* from the viewpoint of relative l.f. response. At (A) the relevant values are shown, R_1 being the source impedance—i.e., the plate resistance of the tube if the transformer is connected in a plate circuit;

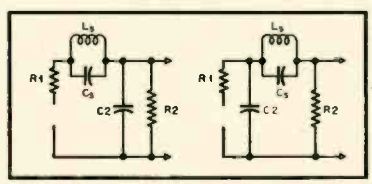


Fig. 6 (left). Equivalent circuit for high-frequency cut-off in a step-up transformer, and Fig. 7 (right), in a step-down transformer.

R_2 is the secondary load resistance, if any, referred by turns ratio squared to the primary side. For example, a shunt resistor of 1 megohm on the secondary of a 5:1 step-up will give a referred R_2 of 1 megohm divided by 5^2 or 25, which is 40,000 ohms.

The shunting effect of L_p must be considered relative to the parallel resultant of R_1, R_2 and R_p. Thus (B) in *Fig. 2* shows a simplified theoretical form of the circuit, where R is the resistance of R_1, R_2 and R_p in parallel. This circuit produces a simple 6 db/octave l.f. cut-off, of the type shown at *Fig. 3*, in which the 3-db point is the frequency where the reactance of L_p is equal to R. Thus the cut-off frequency can be modified by changing either L_p or R. As L_p and R_p are fixed by the transformer, the remaining possibilities for adjusting l.f. cut-off are R_1 and R_2. Reduction of the effective parallel resistance of these two will lower the l.f. cut-off, extending the frequency range.

With a direct-coupled transformer, where the core is polarized, the core is gapped so that the highest possible inductance is achieved when the current for which it is designed passes through the winding. It is wasteful to work the transformer at a current differing appreciably from this value.

A direct-coupled transformer operating in a push-pull plate circuit does not have its core polarized, so a smaller component can be used, and the circuit of *Fig. 2* can be applied, taking care that all impedances are referred to either the whole, or half, of the primary winding, correctly. However, the inductance varies widely with both frequency and level, so the response shown at *Fig. 3* will not be applicable, but the same principle for adjusting l.f. cut-off applies.

Distortion is closely associated with l.f. response because it appears most strongly at this end. Steps that improve l.f. response also reduce distortion due to harmonics in the magnetizing current.

Sometimes transformers are parallel fed, to avoid passing the plate current through the primary winding. Since a coupling capacitor is then necessary, its reactance also becomes effective at low frequencies, so the circuit for l.f. response takes the form shown at *Fig. 4*. Here R_1 is the effective resistance given by the plate resistance of the tube and its coupling resistor in parallel; R_2, as before, is the secondary load resistance, if any, referred to the primary. This circuit is in the form of a resonant circuit, seen more clearly as redrawn at *Fig. 5*, where R_1 is in series with the resonant components C_c and L_p, and the resistances R_p and R_2 are in shunt. For this reason, larger values of R_1 or smaller values of R_2 increase the damping (or reduce the Q) of the resonant circuit.

Less-than-critical damping results in a l.f. peak in the vicinity of cut-off. Critical, or more-than-critical, damping, eliminates any tendency to peak. Choice of suitable values for R_1, R_2, and C_c can result in best possible operation of the transformer in a circuit, as will be shown in detail in following articles.

Response at High Frequencies

At high frequencies the effect of L_p, and C_c if used, will be negligible, and where any appreciable transformation ratio is employed, one of the winding capacitances may usually be neglected. Thus *Fig. 6* shows the h.f. circuit equivalent for a step-up transformer, while

[*Continued on page 55*]

Design and Construction of Horn-type Loudspeakers

WAYNE B. DENNY*

Part I. In the never ending search for good clean bass, builders are turning more and more to the exponential horn—not admirably suited to furniture designs. The two presented by the author should be pleasing, both acoustically and aesthetically.

NUMEROUS REQUESTS for information about a speaker described by the writer in a previous article[1] have indicated that there are many audio enthusiasts who would like to construct horn speakers for their own use but who hesitate to do so without a better understanding of the theoretical and practical considerations which must be taken into account if results are to be satisfactory. Actually, there is nothing mysterious or esoteric about the design and construction of horn-type loudspeakers. The design of a satisfactory unit requires no great mathematical ability. The construction requires no more than a minimum of woodworking ability as far as acoustical performance is concerned. Of course, if appearance is a factor, the skills of a cabinetmaker may be employed for the visible part of the structure.

Theoretical Considerations

The acoustic horn can best be thought of as a transformer which accepts sound energy at its throat and delivers that same energy in somewhat different form at the mouth of the horn. The motion of the air in the constricted portion of the horn near the throat is characterized by relatively high velocity and displacement amplitudes. However, the amount, or mass, of air which moves in this manner is small because the cross-sectional area of the horn is small near the throat. In contrast to the motion of the air in the throat, the motion of the air at the mouth of the horn is characterized by relatively low velocity and displacement amplitudes but the mass of air moving in this region is much larger. An analogy is often made between the acoustic horn and the *impedance changing properties* of an electrical transformer. Thus, for example, a step-up transformer accepts electrical energy at high current and low voltage and delivers that same energy (minus losses, of course) at low current and high voltage. The fundamental purpose of the acoustic horn is to match the impedance of the cone or diaphragm of the driving unit to the impedance of the space into which the sound is to be propagated.

This analogy may be carried a bit further. A good audio frequency transformer must be designed so that its frequency characteristic is essentially flat over the entire audible range. An ideal horn would have a similar frequency characteristic. Electrical transformers are now available which are nearly perfect in this respect but it is found that it is difficult to cover the entire audible spectrum with a single horn if total space occupied by the horn is to be kept within acceptable limits. The physical shape is another factor which must be considered in the design of a practical horn. For these and other reasons it is convenient to use two or more separate horns, each one designed to cover but a portion of the audible spectrum.

The two design factors to be considered are shape and size. The shape will be considered first. Theory and experience[2] indicate that the most satisfactory shape is the so-called exponential horn. An exponential horn is best defined as one which obeys the following equation:

$$A_2 = A_1 \varepsilon^{kx} \qquad (1)$$

where A_1 = cross-sectional area at any point in the horn
A_2 = cross-sectional area at a distance x from the point where A_1 is measured. $(A_2 > A_1)$
k = flare constant
$\varepsilon = 2.718$, the base of natural logarithms

The application of this equation is shown in *Fig.* 1.

For design purposes it is convenient to let $\frac{A_2}{A_1} = \varepsilon^{kx} = 2$. From a table of exponentials

$$kx_d = 0.7 \qquad (2)$$

In Eq. (2), x_d represents the particular increment of horn length in which the area doubles. For a true exponential horn the area doubles for this increment of length no matter what particular value is chosen for A_1 (or A_2).

The value chosen for x_d depends on the lowest frequency for which the horn is to be used. This is called the cut-off frequency, f_c, where

$$4\pi f_c = kc \qquad (3)$$

where c = velocity of propagation of sound in air (about 13,200 inches/second)

After f_c is chosen, k may be determined from Eq. (3) and then x_d may be found from Eq. (2).

Example: Let $f_c = 40$ cps

Then $k = \frac{4\pi \times 40}{13{,}200} = .038$

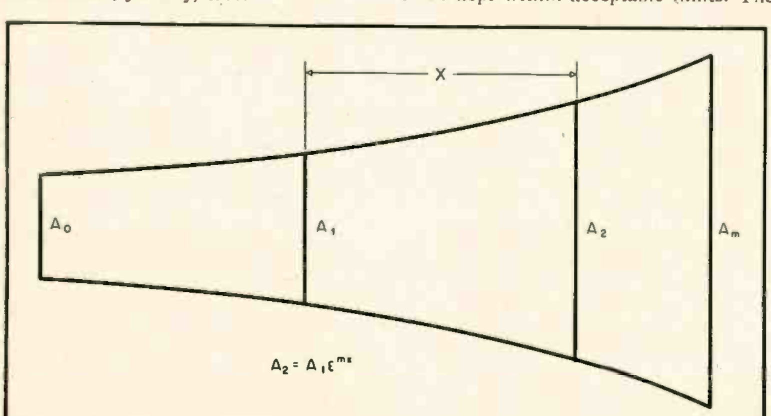


Fig. 1. The rate of expansion of an exponential horn, related to its mathematical expression.

* *Physics Department, Grinnell College, Grinnell, Iowa.*

[1] Wayne B. Denny, "For the discriminating listener: an audio input system," AUDIO ENGINEERING, January, 1950.

[2] Lawrence E. Kinsler and Austin R. Frey, *Fundamentals of Acoustics*. New York: John Wiley and Sons, Inc., 1950. Ch. 11.

Finally, $x_d = \frac{0.7}{0.038} = 18$ inches, approximately.

Therefore the cross sectional area of an exponential horn should double every 18 inches in order to reproduce frequencies as low as 40 cps.

Other Considerations

There are three other considerations about horn shapes that should be mentioned. The first has to do with slight deviations from the exact rate of flare chosen. Experience indicates that for high-frequency horns (tweeters) the shape of the horn should conform as nearly as possible to the design criteria. Since high-frequency horns are small, this requirement presents no great problem. For low-frequency horns (woofers) considerable latitude seems permissible provided that the deviations are small compared with the shortest wavelengths to be used. Actually, there is some advantage in making a low-frequency horn with different rates of flare in different portions of its length. However, such deviations should be gradual and not abrupt.

Another factor in the shape of the horn is the effect of folds or bends. At the lower frequencies there is little difference between a straight horn and a folded horn because differences in path length in different parts of the horn are small compared to the wavelength. At higher frequencies, however, this is not true. Different portions of the wave travel different distances from the throat to the mouth of the horn and trouble occurs when this difference in path length approaches or exceeds one half wavelength. Under this condition it may be expected that there will be marked irregularities in the frequency response and in the directional characteristics of the horn. It is convenient, therefore, to use long, folded horns for the reproduction of low frequencies and to use short straight horns for the reproduction of the middle and higher frequencies. The situation can be summarized by saying that a folded horn has an upper limit to its frequency response as well as a low-frequency cut-off.

There are certain things that should be avoided in the design of folded horns even when they are to be used exclusively at low frequencies. In no case should the shape of the horn be favorable to the generation of standing waves, which are likely to occur whenever there is opportunity for sound waves to bounce back and forth between two parallel surfaces. This type of resonance can be avoided by taking into account the laws of reflection.

The last factor which should be considered about the shape of the horn is the shape of the cross-section. Horns need not be circular. They can be square, rectangular, or triangular. Different sections of the horn can have quite different cross-sections. However, the design should avoid abrupt changes: changes should be gradual throughout the length of the horn.

The question of horn size will be considered next. The throat area, A_o, is determined primarily by the design of the motor which drives the horn. However, no attempt should be made to deliver very large amounts of acoustic power into a small throat area. Under such conditions the variations in air pressure may approach the ambient pressure of the air and serious distortion can result. This is because the elastic properties of air are non-linear except for small amplitudes. Fortunately, for most applications this is not a design limitation. It is convenient, therefore, to give the throat an area whose value is somewhat less that the area of the cone for horns driven by conventional dynamic reproducers. In the case of tweeters the throat area is determined by the size of the coupler attached to the high frequency driver.

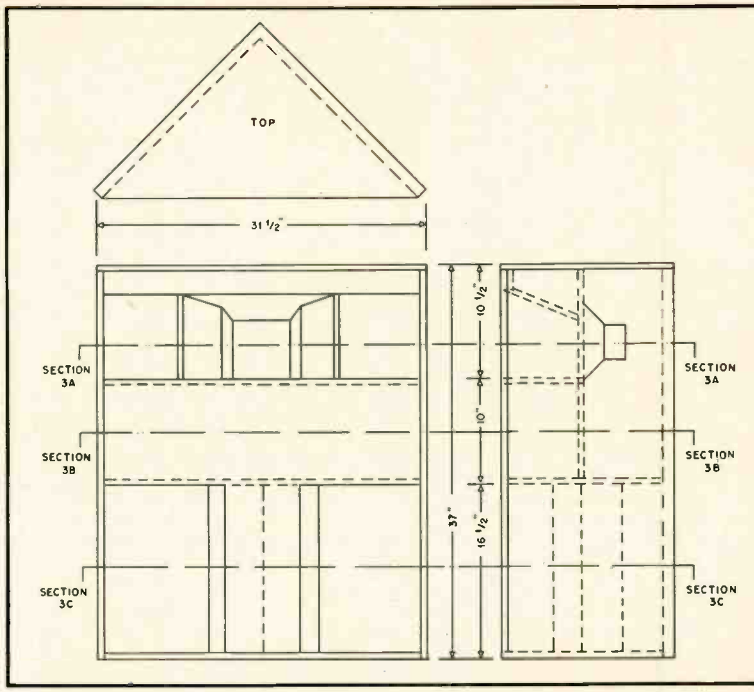


Fig. 2. Elevation of the corner speaker with duplex horn, with basic dimensions.

Next, the mouth area, A_m, must be determined on the basis of the lowest frequency which it is desired to reproduce. It is erroneous to conclude from Eq. (*3*) that the lowest frequency depends solely on the rate of flare. This is because, strictly speaking, Eq. (*3*) applies only to horns which are infinitely long and which have, as a direct consequence, infinitely large mouth apertures. A short review of some elementary acoustical theory will show the importance of the size of the mouth area.

Rate of Flare

According to Eq. (*3*) the less the rate of flare, the lower is k. To take an extreme case, k might be made zero in the hope that the horn will respond to extremely low frequencies. Then, according to Eq. (*1*), the horn degenerates into a tube of uniform cross section. But, as every physics student knows, a long open tube does *not* respond equally to all frequencies. Rather, it exhibits strong resonances at those frequencies for which the length of the tube is

$$l = n\left(\frac{\lambda}{2}\right)$$

where $n = 1, 2, 3, 4$, etc.
and λ = the wavelength = c/f

Eq. (*4*) represents the condition for standing waves which are the resultant of two similar waves moving in *opposite* directions in the tube. The forward wave is the desired mode of propagation while the backward wave is produced by reflections which occur at the open end of the tube. In general, reflections occur wherever there exists a discontinuity in the air column unless the wavelength is very small compared with the diameter of the tube. For a uniform tube, reflections occur at the open end where the cross-sectional area changes abruptly from a small finite value to a large (quasi-infinite) value.

A long acoustic tube may be thought of as an acoustic transmission line with its own characteristic impedance. It is an elementary fact about finite transmission lines—be they acoustic or electric—that reflections will occur at the end of the line *unless the line is terminated in its own characteristic impedance*. The difference between the tube and the horn is this: the impedance of the tube is constant throughout its length while the impedance of the horn (due to its "transformer action" which has already been mentioned) varies throughout its length. At certain frequencies where the wavelength is not small compared with the dimensions of the mouth, the horn will exhibit reflec-

[*Continued on page 50*]

Be Your Own Custom-Builder

Jay Carver* and Cliff Howard*

Even though you are not a cabinet maker, you can make simple and effective installations of radio and phonograph equipment at a fraction of what it would cost if you had someone else do it for you.

Custom building—that is, the sometimes expensive correlation of audible and visible matter pleasant to any number of eyes and ears—is as complicated and time-consuming as one wishes to make it. When a tuner-amplifier-changer-speaker combination has torn a five-hundred-dollar hole in your entertainment budget, we assume you have used a goodly amount of care in your selection. If you plan to economize by compromising on the system housing, then you are about to become a custom builder. After all, cabinetry commensurate with the quality and quantity of these pieces of sound equipment is expensive—very expensive. Fir plywood, butt-jointed and nailed, say you, could never house this finest of equipment. Hardwoods are needed but rarely used. We like to assume good reasoning in the choice of equipment, better reason for the lack of hardwoods—money.

A fine sound system, properly contained in the woods and finishes of your choosing, is not an inexpensive item. It's not a casual addendum to your Saturday morning grocery list. Yet it is possible almost to halve the final cost of a good music reproduction unit by housing the sound system yourself in what can be an exceptionally attractive manner. We believe this cost-cutting applies to one-hundred- as well as one-thousand-dollar systems.

Manufacturers approve of this sort of thinking; it sells equipment. And most of these manufacturers devote a large swatch of their advertising dollar to the publishing of detailed instructions and templates for mounting that expensive tuner or amplifier in your living room. This data comes to you as part of the purchased item, so why not take advantage of it? Why not consider the actual size of this tuner and how best it could be mounted in a closet door or bookcase shelf or coffee table and ask a carpenter what the cost of a fronting panel for the tuner might be?

Is five dollars too much? Then buy a panel of fir plywood and cut it out yourself. This panel for the tuner can be less than a square foot of whatever wood you choose, and a matching finish isn't expensive. If your bookcases are painted, the cost can be measured in parts of dollars. Better still, the tuner might even come in a separate cabinet. No mounting expense required. Try a bookshelf for this sort of unit, using books as tuner-ends. The cabinet-mounted tuner becomes the center of that particular area of interest. And, it's accessible.

Any piece of sound equipment can be installed in such a manner. The acquisition of this equipment meant the acceptance of an entirely different concept of the mechanics for reproducing recorded and broadcast sound. So, having discovered the flexibility of your newest sound system, why not explore its decorative possibilities? These are just

* *The Electronic Workshop, 351 BleecherSt., N. Y. 14, N. Y.*

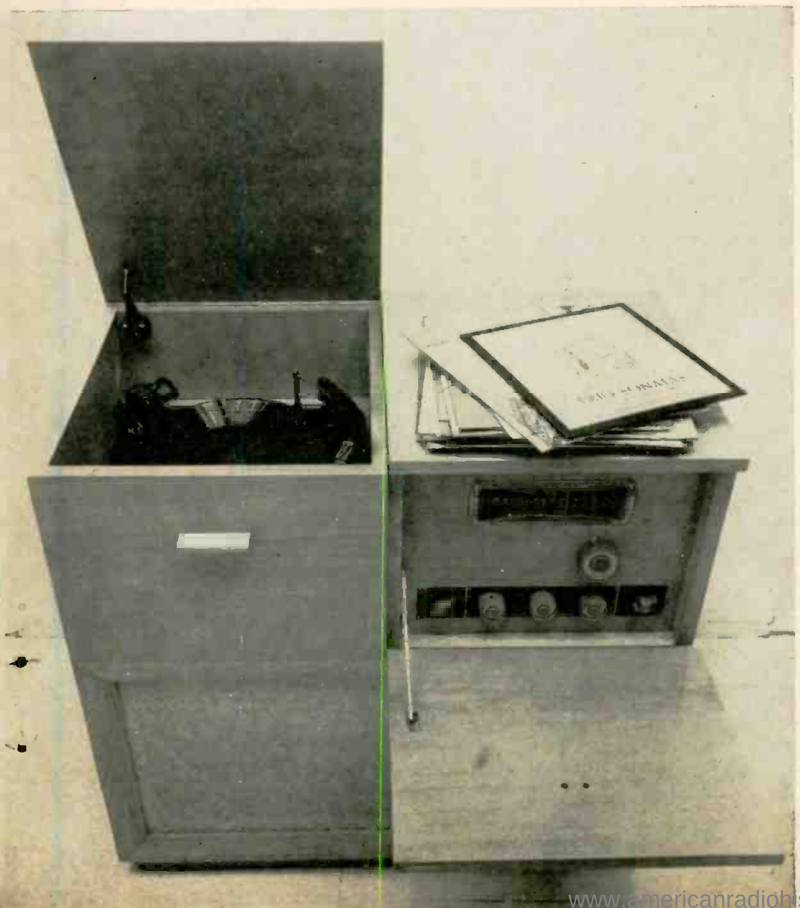
A simple but handsome cabinet such as the one shown in these two views suffices to hold the four basic elements of a home system—tuner, record player, amplifier, and speaker.

as many and as varied as the many and varied sound systems available today. Too, the ownership of this equipment hints at appreciation of arts other than music—design, literature, the dance. In other words, why sate but one sense? The more ear-pleasing your system, the better it should look. Using existing furniture or planning and building economical cabinetry, such eye-appeal is possible.

Think of the FM tuner you might have coveted. It can be placed a fair distance from its amplifier . . . in whatever setting you wish or can imagine. Would you like it facing your favorite listening spot from an attractive setting in a bookcase? If not this, have you thought of it being mounted facing upward in the top shelf of a low bookcase that might contain your record player and other controls? Or build it into that pine commode or that corner cabinet using as a dial panel the bottom of a drawer from one of those units. Try wherever possible to match in woods and finishes the eventual housing of your unit.

Tuners, should you have forgotton, require only a rectangular cutout for the dial and from one to seven ⅜-in. holes for the knobs. Most tuners are sold with attractive escutcheons to frame the dial cutout, so your lack of skill with a small saw doesn't show. Even if holes splinter, the knobs usually are large enough to cover your shortcomings as a cabinet-maker. The shelf within the tuner enclosure can be anything wooden—just locate it conveniently. Repairs someday may be needed.

Stringing connecting cables from the tuner to amplifier should be your neatest work. Care at this point of installation could save you many dollars later when a serviceman may be needed. Let him spend several hours undoing your complex installation when removing a faulty item, and you will lose money. Too, parts houses usually offer an *F.O.B. The Shop* clause in the equipment guarantee. It means when a tuner or other unit acts up the repair guarantee becomes effective only when the unit is returned to the dealer (or manufacturer). Accessibility of these units within the installation means a saving to you of time, and, more important, money.



Tuner mountings, then, can be as different or practical or complex as you care to make them. Again, this applies to the entire system with the exception, perhaps, of the loudspeaker. On tuners, try the parts catalog again. This time consider the decorative possibilities of the many advertised tuners. Iconoclastic though this may seem, you'll notice that each unit differs from the next in a way that may prove the answer to your particular problem. Many of these differences are physical, their performance characteristics being almost identical. Why not use the one best suited to the way you intend to use it?

If your new amplifier has its own controls, remove the volume control from the tuner—hack saw will do the trick. Now there's only a tuning knob. The installation becomes more manageable with fewer knobs to confuse the eye. If the tuner hums while the record player is on, mount an unobtrusive ON-OFF switch elsewhere on the control panel for the tuner.

Amplifiers present a somewhat different mounting problem. Inexpensive units with tone controls and selector switches on the same chassis are actually more difficult to place than an expensive amplifier with the same controls in a remote unit. The latter might be used as just that without bothering to install it permanently. It's a compact unit, usually quite attractive. Mounted, it could show directly under or next to the tuner. All controls then are inches apart. If space is not available for the tuner and amplifier you want, and the amplifier just won't fit in the same enclosure as the tuner, place the amplifier back of the tuner chassis and use flexible shaft entenders. You'll have the amplifier controls next to the tuner, but only the depth of the enclosure, not the height, will be used. Think of the amplifier as the center of the system. Your tuner, record player unit, and loudspeaker find a junction in the amplifier. If it doesn't use a remote control unit, the controls will have to be accessible. All of which leave you with a cable-stringing problem.

We think it best to control the power sources for the tuner and record player from the control switch on the amplifier. None of these units can be used until the amplifier has been turned on. But, if the tuner and player are installed as remote pieces of cabinetry, this matter of cable-stringing can become messy. The tuner has three cables—antenna line, a.c. power cord, and audio output. The record player, lacking antenna, has the other two. Four times this amount of hookup line isn't easily hidden. Try connecting the a.c. cord from each component to the nearest wall outlet, and then use the smallest insulated cable available for the connection to the amplifier. (We use phono cable 1/16-in. in diameter; it hardly can be seen.)

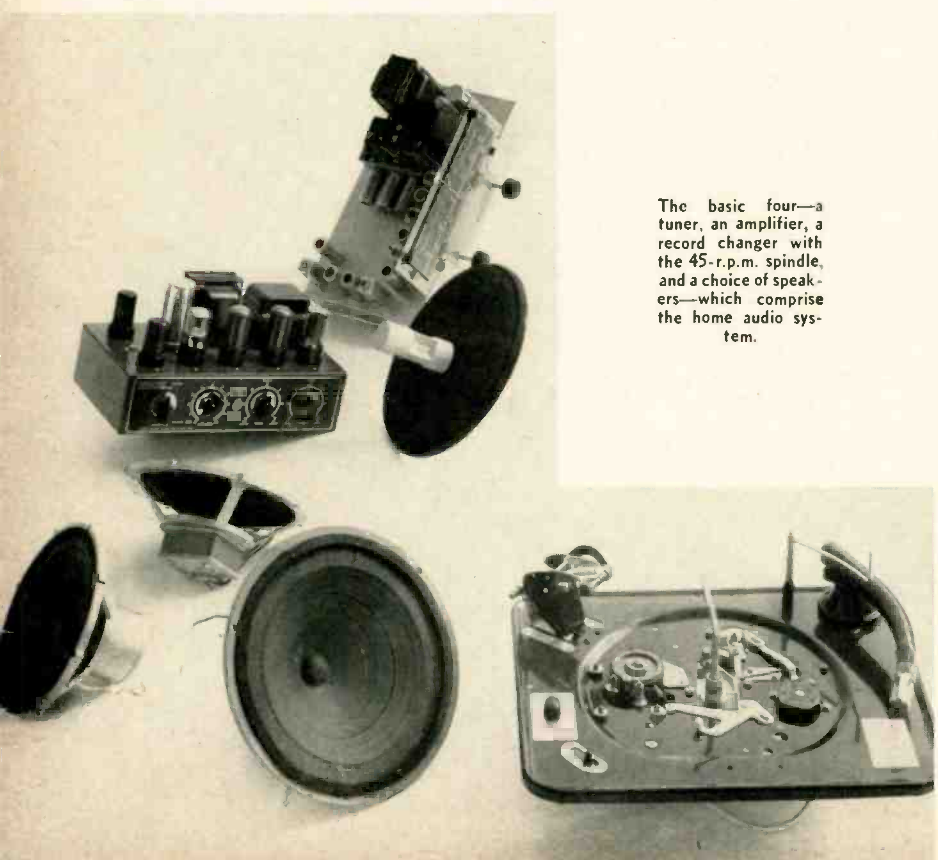
For connecting the speaker case, use inconspicuous telephone hookup line, or, to hide it completely, try 300-ohm antenna line under the living room rug. It's flat and pretty sturdy.

With these units mounted in the same cabinet, however, problems other than neatness of wiring begin to show themselves, and, what's worse, begin to make themselves unpleasantly heard. If the mounting is a horizontal one (as on a bookcase shelf), remember that a magnetic cartridge too close to a transformer will hum. In such a case, install the phonograph at the far left. Record players in such arrangements sometimes seem much the less practical devices than they might. Changer vibration (we call it rumble) is transmitted through the system, sometimes through lack of care in mounting the system. It's not an insurmountable problem. Foam rubber, placed under tuner and changer mounting boards, can sometimes remove this unmusical type of disturbance. Try the foam rubber underneath the speaker baffle, even though it's in another part of the room. If the amplifier must be located near the cartridge and there's hum, try reloading the amplifier within its enclosure until you have found a placement causing the least hum.

Then there's a matter of heat. Did you know that some transformers are partially filled with pitch? It's only a stuffing around the working parts of the unit. If you don't provide adequate ventilation for your amplifier (or other units), you will soon realize this important fact of transformer life—expensively. Hot enough, the pitch will melt and pour out of the transformer. By then, the transformer has ceased to function and you need a repairman. Ventilating holes can be carefully cut, tastefully covered with metallic grillwork. Sometimes, and we've done it many times, the ventilating holes can be an integral part of the amplifier design.

On most amplifiers you will find an escutcheon plate inscribed with various legends. Remove it by taking off the knobs and the control knob nuts. Mount it on the outside of your new dial panel, or, if it lacks an esthetic appeal, buy decals from a radio parts house, applying whatever legends you feel necessary to operate the unit. On matters esthetic, incidentally, try a razor blade on the glass dial of your new tuner. If it's silk-screened, the sharp edge quickly removes any advertising and unnecessary tuning information on the dial. If the flocking behind the glass offends your critical eye—it's usually plum-colored—ordinary ink in a shade of your choosing will do the trick and will give your tuner dial the original touch you sought when you bought it.

Mounting the record player isn't too much of a problem unless space is critical. If a changer must be used, then remember that some domestic units require as little as thirteen inches in depth. Even this measurement extends beyond the depth of the average bookcase, and if such an installation is needed, here is one suggestion. Most changer companies sell wood and metal bases for their changers. Find a base for your changer, fix to the inside of a hinged front for one section of your bookcase. You will need no more than ten inches of depth and the average bookshelf offers more by one or two inches. Or mount the base on inexpensive metal slides anywhere in any piece of furniture offering the needed space.



The basic four—a tuner, an amplifier, a record changer with the 45-r.p.m. spindle, and a choice of speakers—which comprise the home audio system.

And so to speakers. And, with our ideas, to fewer friends. We assume you have the speaker (or speaker system) best-suited to your budget-wise ear. We assume, too, that budget limitations will determine the eventual placing and housing of your speaker. And again we assume you have plumbed the many and varied speaker baffles for the buying and building. Assuming this much, we offer a practical, money-saving baffling idea—try a "tuned" baffle. You are not restricted to [*Continued on page 57*]

The Best British Records of 1950-1951

H. A. Hartley

WHEN THE LIST of Best British Records of 1949 was run in these pages in November 1950, it was prefaced by a few comments which are equally applicable to this compilation. In substance, therefore, the same comments are repeated here along with some new ones.

These records have been selected because they are well performed and well recorded, in this reviewer's opinion. It seems futile to recommend a technically-good recording if the musical interpretation is unsatisfactory, and an excellent performance badly recorded is a constant irritation, as well as a reminder of what might have been.

Catalog numbers are British ones, and some titles may be available with American labels. While record-shop experts should be able to give cross references, the performers and conductors indicated will probably provide the clue in most cases. Now for the new comments:

While it is recognized that the 78 record is almost a dead issue in America, the obvious thing was to prepare this list on the basis of giving first choice to the LP recording provided it was at least as good as a competitive recording on 78, and leave the 78 out of the list as being of little but academic interest. The list is thus considerably shortened, without impairing its usefulness. On the other hand if the 78 recording was a better job than the LP edition of the same work (by a different company) then the LP was left out. This will explain why you will find some LP's omitted, even though you know they are in the catalog. The list is based on this writer's opinions, whether good or bad. At least you can be sure that the records were reviewed on first-class equipment which would show up any defects of recording.

Leaving equipment problems—all of which can be overcome—an amusing inconsistency in the aesthetic approach to one section of the musical repertoire was recently observed in two issues of The Gramophone. In August, one reviewer reported:

"Now Charles Mackerras . . . demonstrates by his brilliant rearrangement of Sullivan's tunes . . . that divorced from Gilbert's no-longer-funny words and those laboriously fossilised stage productions, the music actually benefits and can take on a fresh lease of life. . . ."

In the November issue, another reviewer says:

"First of all I believe most firmly that the genius of the Savoy pair was Gilbert; anyone who takes the trouble to read the plays as plays will discover this if he cannot do so otherwise—for example, from the fact that Sullivan was no great shakes as a composer away from his colleague."

Obviously there is a certain emotional set-up which is quite likely to modify any opinion formed as to performance and recording—even before the needle is put in the first groove. Some excellent examples may have been missed because this reviewer does not like operas, with the exception of Die Fledermaus, Schwanda—etc., The Perfect Fool, and Gilbert and Sullivan. The particularly objectionable ones are Tristan and the Ring when the singing starts. Apart from such foibles, the list is believed to be reasonably complete.

The following contractions are used:

H.M.V.: His Master's Voice. **Col.:** Columbia (British). **Parlo.:** Parlophone.
Decca: Decca (British) which may not be listed in the London catalog.
Lon.: London (i.e. Decca available in America and listed in the London catalog).
All H.M.V., Columbia, and Parlophone records are 78's.
All London records are LP's. A Decca number preceded by * indicates LP; otherwise it is a 78.
L.P.O.: London Philharmonic Orchestra. **L.S.O.:** London Symphony Orchestra.
R.P.O.: Royal Philharmonic Orchestra. **Ph.O.:** Philharmonic Orchestra.
C.O.A.: Concertgebouw Orchestra of Amsterdam. **V.P.O.:** Vienna Philharmonic Orchestra.
O.S.C.C.: Orchestre de la Société des Concerts du Conservatoire de Paris.
P.O.: Philharmonic Orchestra. **S.O.:** Symphony Orchestra. **acc.:** accompanied.
The conductor's name is given in parantheses after the orchestra.

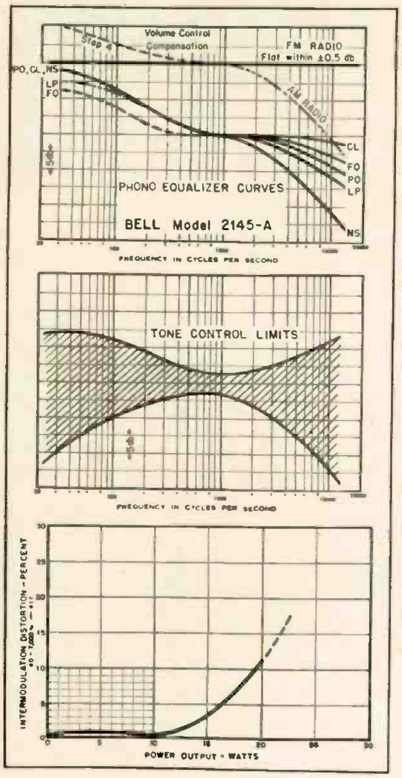
ORCHESTRAL

Auber	Overture: Fra Diavolo. Boston Pops O. (Fiedler)	**H.M.V. C4010**
Alfven	Midsummer Vigil (Swedish Rhapsody) Cincinnati S.O. (Johnson)	**Lon. LLP406**
Bach, J. S.	Brandenburg Concertos Nos. 1 & 5.	**Lon. LLP222**
	Brandenberg Concertos Nos. 2 & 3.	**Lon. LPS226**
	Brandenburg Concertos Nos. 4 & 6. all by Stuttgart Chamber O. (Münchinger).	**Lon. LLP144**
	Suite No. 3 in D. Stuttgart C.O. (Münchinger).	**Lon. LPS147**
Balakirev	Symphony in C. Ph.O. (von Karajan).	**Col. LX1323/8**
Bantock	Fifine at the Fair. R.P.O. (Beecham).	**H.M.V. DB21145/8**
Beethoven	Symphony No. 5. O.S.C.C. (Schuricht).	**Lon. LLP7**
Berlioz	Excerpts from Romeo & Juliet, and Royal Hunt & Storm. O.S.C.C. (Münch).	**Lon. LLP3**
Bizet	Carmen Suite & L'Arlesienne. L.P.O. (van Beinum).	**Lon. LLP179**
Borodin	Overture & Polovtsi March (Prince Igor) Ph.O. (Dobrowen).	**H.M.V. C3579/80**
Brahms	Symphony No. 4. L.S.O. (Krips).	**Lon. LLP208**
Debussy	Images pour Orchestre. O.S.C.C. (Ansermet).	**Lon. LLP44**
	La Mer. O. S. R. (Ansermet).	**Lon. LLP388**
Dukas	L'Apprenti Sorcier. O.S.C.C. (Jorda).	**Lon. LPS193**
Dvorak	Scherzo Capriccioso, Op. 66. Ph.O. (Kubelik).	**H.M.V. 7822/3**
Grieg	Holberg Suite. Boyd Neel O. (Boyd Neel).	**Lon. LPS173**
	Sigurd Jorsalfar. Cincinnati S. O. (Johnson).	**Lon. LLP406**
Ippolitov-Ivanov	Caucasian Sketches. O.S.C.C. (Desormiere).	**Lon. LLP440**
Mozart	Eine Kleine Nachtmusik. V.P.O. (Karajan).	**Col. LX1293/4**
	Symphony No. 36. K425. Danish State O. (Busch).	**H.M.V. DB20115/7**
	Symphony No. 40. K550. L.P.O. (Kleiber).	**Lon. LPS89**
	Symphony No. 41. K551. R.P.O. (Beecham).	**LX1337/40**
Ravel	Ma Mere l'Oye. O.S.C.C. (Ansermet).	**Lon. LLP388**
Rimsky-Korsakov	Scheherazade, Op. 35. O.S.C.C. (Ansermet).	**Lon. LLP6**
Rossini	Overture: La Cambiale di Matrimonio. R.P.O. (Beecham).	**Col. LX1458**
Rossini-Respighi	La Boutique Fantasque. L.S.O. (Ansermet).	**Lon. LLP274**
Schubert	Symphony No. 8. (Unfinished). L.S.O. (Krips).	**Lon. LPS209**
Sibelius	Symphony No. 6, Op. 104. R.P.O. (Beecham).	**H.M.V. DB6640/2**
Stravinsky	Petrouchka, Ballet suite. O.S.C.C. (Ansermet).	**Lon. LLP130**
	L'Oiseau de Feu. O.S.C.C. (Ansermet).	**Lon. LPS300**
Strauss, R.	Also Sprach Zarathustra. V.P.O. (Krauss).	**Lon. LLP232**
Tchaikovsky	Symphony No. 6. O.S.C.C. (Münch).	**Lon. LLP257**
	Capriccio Italien, Op. 45. Ph.O. (Kletzki).	**Col. LX8736/7**
	Romeo & Juliet Overture & Francesca da Rimini. O.S.C.C. (Jorda).	**Lon. LLP376**
	Variations on a theme from Suite No. 3. Ph.O. (Malko).	**H.M.V. C4058/60**

(*Continued on page 58*)

Equipment Report

BELL 2145-A Amplifier



WITHIN THE LAST TWO YEARS, equipment manufacturers have recognized the requirements of the hi-fi enthusiast, and have made a number of improvements on amplifiers and other units to provide the features most desirable for home use. An outstanding example of this forward-looking trend is the Bell Model 2145-A amplifier, which we have selected as the first of this series of amplifier equipment reports.

While a large number of amplifiers have been introduced with separate control units, none has yet been completely suitable for use at some location remote from the main amplifier. Some of the later models are equipped with cathode followers so the length of the connecting lead is relatively unlimited, yet in all except the Bell the input circuits must be connected to the control unit, thus making it difficult to locate the preamplifier-control section at the user's favorite armchair or on a side table some distance from the tuner and phonograph turntable.

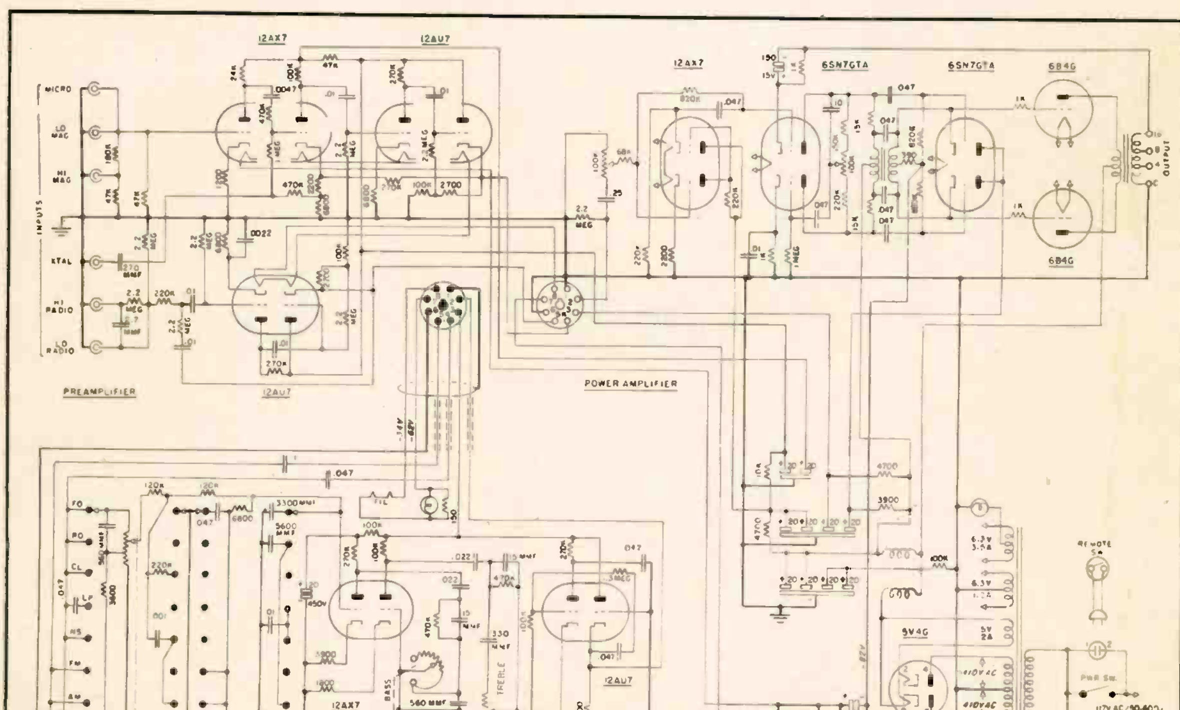
With the 2145-A, all inputs are plugged into the main amplifier chassis, and sufficient preamplification is furnished that the signal fed to the control section is of a level high enough to minimize the effects of hum or crosstalk. Inputs from tuner and from phonograph are fed to the control unit by cathode followers at a relatively low impedance—approximately 300 ohms—and after being "selected," equalized, and adjusted for tone and volume, are fed back to the amplifier chassis by another cathode follower. Furthermore, the remote unit is fed with d.c. for the heaters of the two tubes employed, and no a.c. appears in the connecting cable, which may be as much as 25 feet long.

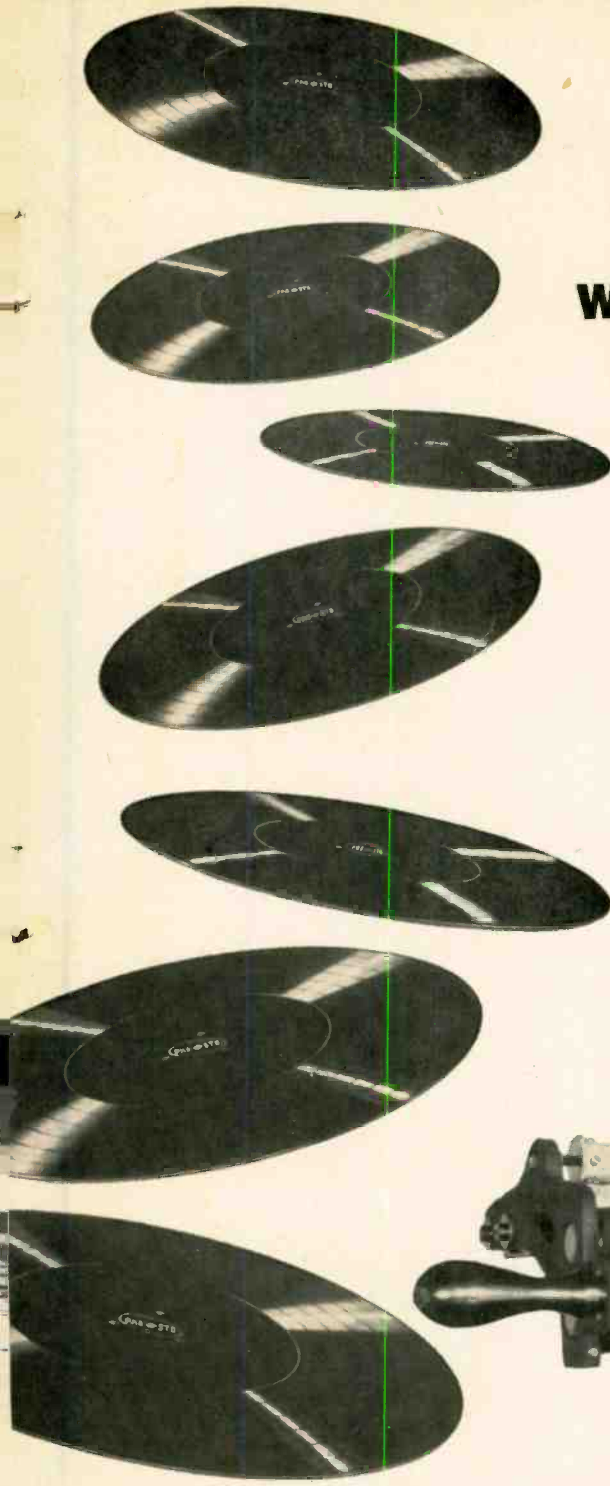
The 2145-A employs triodes throughout, with 6B4-G's in the output stage being driven by push-pull cathode followers as the driver stage. Power output was measured at 25 watts with a line voltage of 114, and was less than 3 db down at 20 and 20,000 cps. Distortion measurements are shown at the left, along with response curves for phono and radio inputs.

Equalization Controls

The selector switch performs the basic equalization for the phonograph connection,

[Continued on page 46]





when the chips are down...

On the surface most discs look pretty much alike. And for some jobs, their characteristics may seem fairly similar, too. But can you depend on them? Are you sure that the discs you use will give consistently fine performances for any kind of job day in and day out?

You can if you select PRESTO.

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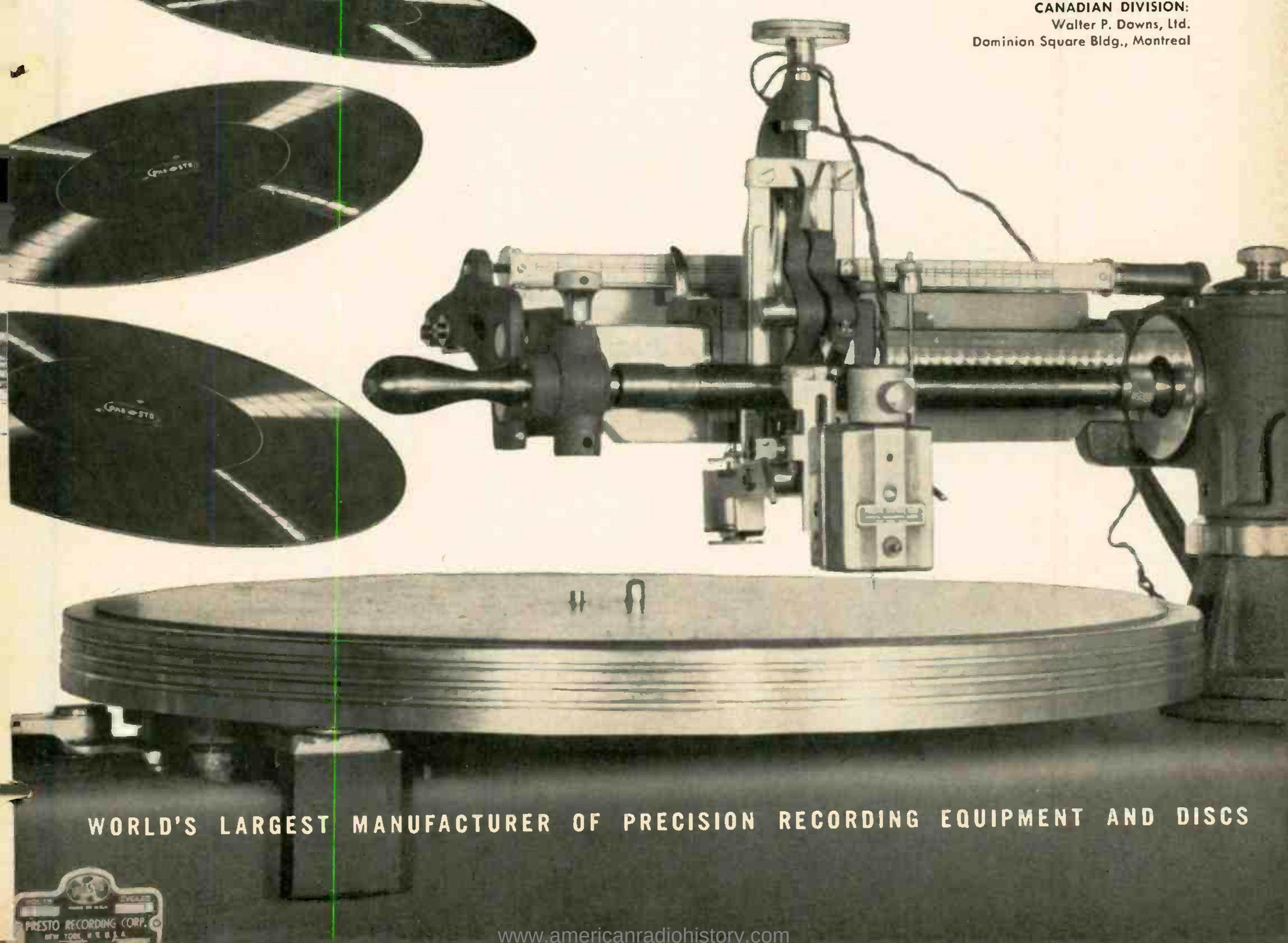

AUDIO engineering society

Containing the Activities and Papers of the Society, and published monthly as a part of AUDIO ENGINEERING Magazine

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

New York Section Concludes Third Lecture Series

WITH AN ENROLLMENT of over 120 enthusiastic audio-minded individuals—both members and non-members—the Third Lecture Series given by the New York Section of the Audio Engineering Society concluded on February 14, after a six-week course. The subject of the current series was "Amplifiers," important to anyone in audio work, either professionally or as a hobby.

The first lecture, given on January 10 by Hermon Hosmer Scott, provided the introduction to the entire series under the title "The Amplifier and Its Place in the Circuit—a Survey." In his talk, Mr. Scott covered the essentials involved in amplifier design and operation, primarily to point out what is necessary in any study of amplifier planning. The relation of the amplifier to other elements in the system was pointed out, and the requirements of performance and the necessary power supply problems were reviewed.

W. R. Ayres, of RCA Victor Division, discussed "Power and Voltage Amplifiers" in the second lecture. His approach was primarily from the viewpoint of the designer of actual circuitry, and covered in a competent manner the choice and use of tubes.

G. Grenier and Myron R. Coe, both of Langevin Manufacturing Corporation, shared the third evening, the former discussing special preamplifier problems in professional applications, while the latter covered power supplies.

James Wilson, of National Broadcasting Company, presented an enlightening talk on the "Design of Complete Amplifier System" for the fourth evening, largely for the non-professional user of amplifiers.

Again with two lecturers, the fifth evening brought R. S. Gerhold and S. F. Danko, both from Signal Corps Engineering Laboratories at Fort Monmouth, with discussions of components and their characteristics, and miniaturization—an important subject in current electronic design practice.

The course concluded with a discussion of "Measurement Methods," given by H. B. Hoeper of Airborne Instruments Laboratory, Inc. This lecture described current practice in measuring gain, frequency response, input and output impedance, and distortion—both harmonic and intermodulation.

All who attended the series were given lecture notes prepared by the individual speakers for their respective talks, and similar in content to those of the first two lecture courses. These notes will be made available to members and non-members at nominal fees as soon as all who registered have obtained those notes for lectures at which they may not have been present. Announcement will be made on this page as soon as the availability is determined.

The Audio Fair in Chicago

Following immediately after the annual Radio Parts Show in May, the first Audio Fair in Chicago will open its doors at 10:00 a.m. on Friday, May 23, and run until 9:00 p.m. on Saturday, May 24.

Choice of these dates makes it possible for many exhibitors who will already be set up for the Parts Show to remain for two more days and display their audio products with a minimum of effort in preparing for the onslaught of midwest audio engineers and hobbyists. The Parts Show, never open to the public, occupies the fifth and sixth floors of the Conrad Hilton Hotel from May 19 to May 22, and those exhibitors with audio products can remain for two more days in the newest Audio Fair. Distributors, and those manufacturers who are not exhibiting at the Parts Show, will be assigned rooms on the seventh floor of the hotel, and all three floors will be open to the public for the two days of the Fair, according to Harry N. Reizes, Fair Manager.

The unparalleled popularity of the yearly Audio Fair, held in New York each Fall in conjunction with the Society's Annual Convention, is expected to be duplicated with the midwest showing, and members and enthusiasts in the Chicago area are exhorted to mark May 23 and 24 in their date books early to make sure that they do not miss the newest Fair.

The Society is sponsoring the Chicago event, as it does The Audio Fair each year in New York.

Back Issues of AES Papers Available

For the benefit of members who may have misplaced their Society publications, or for non-members who may wish to obtain a complete file of AES papers, the Secretary's office announces the availability of sets of previously published papers. These sets may be obtained by writing the Secretary, Audio Engineering Society, P. O. Box 12, Old Chelsea Station, New York 11, N. Y. accompanied with a remittance of $1.00 for members and $2.00 for non-members.

The available papers include: "Longitudinal noise in audio circuits," by H. W. Augustadt and W. F. Kannenberg of Bell Telephone Laboratories; "The diamond as a phonograph stylus material," by E. J. Marcus and M. V. Marcus; "Automatic audio gain controls," by J. L. Hathaway; "Sound reinforcing systems," by Arthur W. Schneider; "Loudspeaker damping," by Albert Preisman; "The effect of sound intensity level on judgment of 'Tonal range' and 'volume level,'" by Stephen E. Stuntz; "A new method of measuring and analyzing intermodulation," by C. J. LeBel; "Toward a more realistic audio," by Ross H. Snyder; "The measurement of audio volume," by Howard A. Chinn; and "Direct radiator loudspeaker enclosures," by Dr. Harry F. Olson.

At the present time, all of these papers are included in the sets, and all will be supplied as long as they are available.

MEMBERSHIP APPLICATIONS

The lack of an application form may have deterred many who wish to join the Society from actually doing so. However, for their convenience, such a form may be found on page 64 of this issue. Please note that the remittance for the grade desired must accompany the application, and that the form must be signed by the applicant.

Employment Register

POSITIONS OPEN and AVAILABLE PERSONNEL may be listed here at no charge to industry or to members of the Society. For insertion in this column, brief announcements should be in the hands of the Secretary, Audio Engineering Society, P. O. Box 12, Old Chelsea Station, N. Y. 11, N. Y., before the fifth of the month preceding the date of issue.

★ Positions Open ● Positions Wanted

★ **Radio Engineers.** The Department of State needs radio engineers at present and under-construction relay bases overseas for its Voice of America program. Salaries are from $4719 to $6807 plus a tax-free allowance for rent, heat, light, fuel, and electricity. In addition, there is a variable allowance to adjust for living costs at posts where the cost of living has been determined to exceed that prevailing in Washington, D. C., and a differential is also paid to employees serving at posts which are considered to have exceptionally difficult living conditions.

Interested American citizens of at least five years' standing and who are willing to serve at any post abroad for a continuous period of not less than two years may obtain further information by writing a resume of their qualifications to the Division of Foreign Service Personnel, 1734 New York Avenue N.W., Washington, D. C.

AM·FM·TELEVISION

Consolette

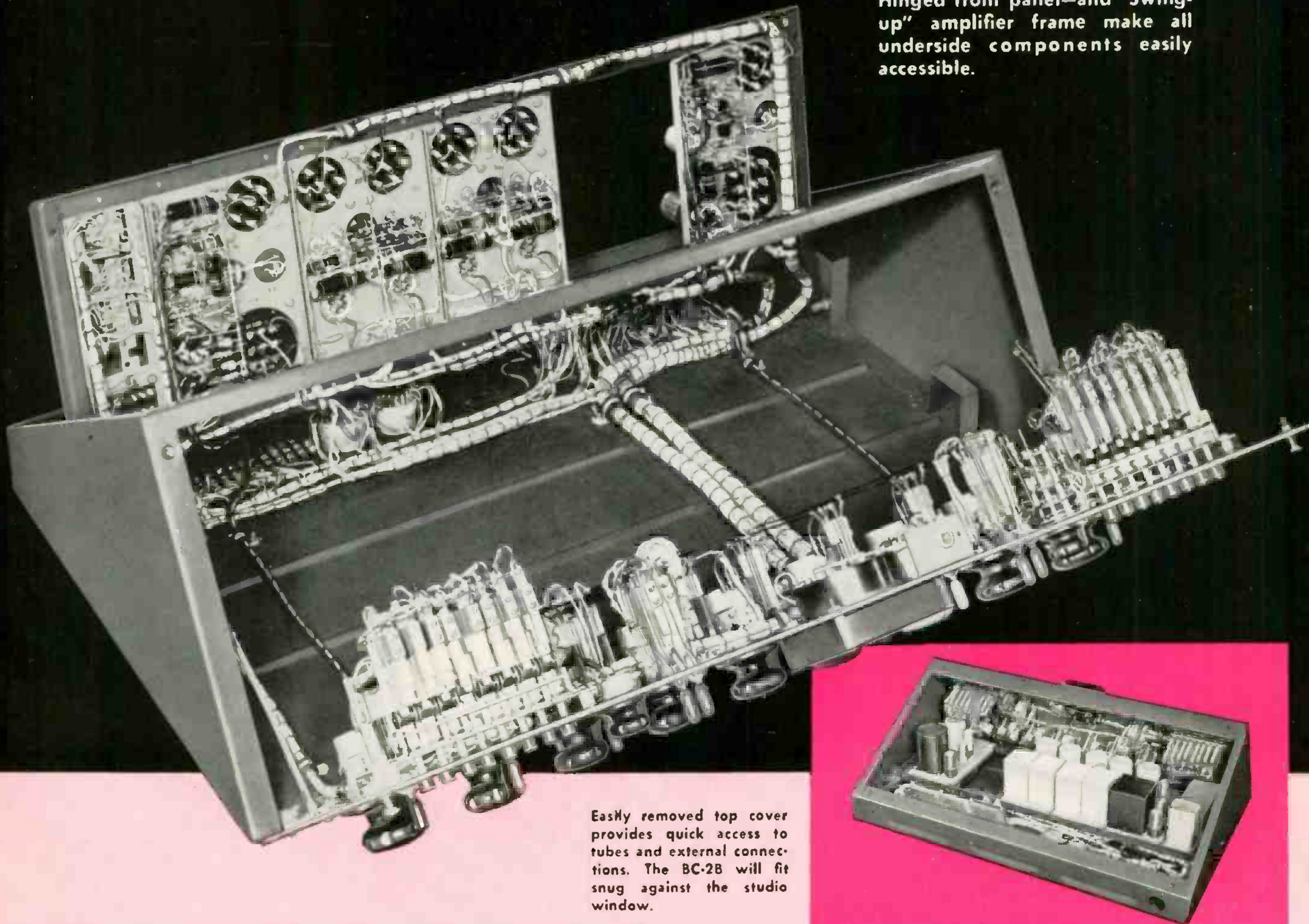
"All-New" Design

NEW STUDIO CONSOLETTE, TYPE BC-2B

RCA

"Color-coded" controls tie related functions together. 30 sloping front and top provide maximum studio visibility. Zero-rear-clearance feature makes it practicable to install the BC-2B tight against a studio window. Less operating space required. Type BC-2B is six inches shorter than previous models! See next page.

Hinged front panel—and "Swing-up" amplifier frame make all underside components easily accessible.



Easily removed top cover provides quick access to tubes and external connections. The BC-2B will fit snug against the studio window.

NEW DESIGN consolette

Color coded for "error-proof" control

Cam - operated, "leaf-type" interlocking push-button switch.

The new consolette BC-2B provides all the essential audio facilities needed by most AM, FM, and TV stations — plus many extra operating advantages not previously available in a standard consolette. It speeds up switching operations substantially over previous designs. It provides for complete control of all studio operations. *The BC-2B gives your station "deluxe" features at a "standard" price.*

Read the list of exclusive "extra" features the new BC-2B offers you. Then ask your RCA Broadcast Sales Representative for complete details. His service is as near as your phone.

11 extra features!

- *"Color-coded" controls quickly identify and tie related functions together.*
- *New, leaf-type cam-operated interlocking, push-button switches.*
- *New hinged front panel for easy access to switches, gain controls, and contacts.*
- *Amplifiers mounted on "swing-up" frame; chassis easy to remove.*
- *New 30° sloping top panel for maximum studio visibility—styling compatible with modern AM and TV practice.*
- *New compact amplifiers use low-noise, long-life, miniature tubes.*
- *Improved, faster-operating speaker relays eliminate key clicks and audio feedback.*
- *Lamp dimmer for VU meter (ideal for TV service).*
- *8 high-level mixing channels, separate gain controls for network and remote.*
- *Turntable mixers with "built-in" cueing switches.*
- *No clearance required at rear—can be installed up against walls and control room windows. Uses less desk space, too.*

RCA

RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT — CAMDEN N.J.

How to Use Magnetic Pickups

Ulric J. Childs*

Adapting a radio-phonograph to use a magnetic pickup is a simple operation if you use the methods described by the author. All the equipment is readily available, and there is nothing to build.

THE PRESENT TREND among people who like good music and like to have it sound better is to replace crystal phonograph pickup cartridges with magnetic-type cartridges such as the Audak, Clarkstan, General Electric, Pickering, and others. Magnetic cartridges are capable of better performance than most crystals because they give much smoother reproduction and are able to extend the music reproduction to the higher overtones. However, you can't eat your cake and have it too—in audio any more than in a restaurant; for along with the *potentially* fine results goes the necessity to add something to the other parts of the system. If you don't do it, or if you do it wrong, the fine results remain potential and your time and money have not been spent in the most gainful way.

All crystal and magnetic pickups are small electrical generators. But modern magnetic pickups generate far less than crystals. To get sufficient power from the amplifier to drive the loudspeaker, the amplifier must do a bigger signal-magnifying job—and most amplifiers designed for crystals just don't have enough amplifying capability to do it. Standard radio-phonographs are included in this category. The simple and effective answer is to add a preamplifier, which is a small amplifier increasing the capability of the existing one. The prefix "pre" indicates that it is connected *before* or *ahead of* the main amplifier, usually between the magnetic pickup cartridge and the amplifier itself. *Fig.* 1 is a block diagram showing the record-playing chain, including a preamplifier.

Several phonograph preamplifiers are sold especially for this purpose. In this article we shall describe only a few of them to indicate how they should be used.

Figures 2 and 3 show the General Electric SPX-001 and UPX-003 preamplifiers. They are the same, except that the UPX-003 (*Fig.* 3) has its own built-in power supply and is energized from a 115-volt a.c. outlet; the SPX-001 has a four-wire cable which is connected to the power supply within the amplifier with which it is used. There is no significant difference in performance—it's simply a question of whether or not it is convenient to take power from the amplifier. Many amplifiers today have sockets for this purpose, and a plug may be soldered to the end of the 4-wire cable and inserted in this socket. Commercial radio-phonographs do not have this socket so that soldered connections must be made inside the chassis to obtain power if the SPX-001 is used.

The GE preamplifiers have enough amplification to compensate for the low output of any magnetic cartridge, more than enough, in fact, for some, though this is not harmful. To install it, power must first be provided as outlined previously. Then the plug on the shielded cable coming from the pickup arm must be inserted in the input jack, seen on the side of the chassis in the photos. This is the same kind of jack as appears on most amplifiers and radio-phonographs, so presents little problem. If, however, the pickup cable ends in some other type of plug, it must be removed and the correct plug soldered in place. Any radio parts store or serviceman can supply the correct plug. A shielded cable comes from the preamplifier (it does not appear in the photographs) and has a similar plug at its end which is to be inserted in the jack on the amplifier or radio-phonograph. Again, if the jack does not correspond to the plug, a parts store or serviceman can supply the correct one. In both cases, a technician or serviceman should do the soldering job unless the owner is familiar with the work.

The Pickering Model 230H preamplifier appears in *Fig.* 4. The gain is slightly less than that of the GE preamplifier, but still sufficient. It has the same connection provisions as the GE units, but is available only with built-in power supply. The distortion of the Pickering is extremely low (a maximum of 0.2 per cent intermodulation at normal output level).

There is another and extremely important job that must be done for best results when a magnetic cartridge is used—equalization. Each recording company emphasizes the volume level at certain portions of the pitch range—this is

Fig. 4. Another self-powered preamplifier is the Pickering, Model 230H, with vibration-reducing rubber grommets for mounting.

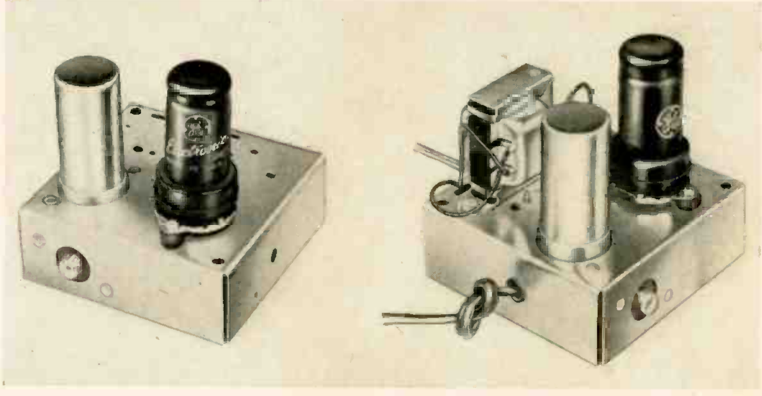


Fig. 2 (left) and Fig. 3 (right). Two types of General Electric preamplifiers—SPX-001 at left requires power supply from the amplifier or radio chassis, and UPX-003 at right, which is self-powered.

* *1601 First Ave., New York 28, N. Y.*

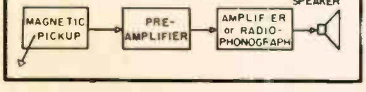


Fig. 1. Block diagram of the basic elements of a record-playing system using a magnetic pickup.

known as pre-emphasis—and reduces that of other parts. Generally the higher frequencies are emphasized. In playing back, we must reduce the highs to offset the pre-emphasis, and in so doing we reduce surface noise, too. The problem is to reduce the highs in approximately the same way as the manufacturer emphasized them. In addition, the bass range is attenuated in recording to avoid cutting over into adjacent grooves. To offset this, we must emphasize the bass in playback, again in just the right way. The rub is that different record makers do these two things in different ways. Ideally, therefore, we should have controls to change the treble attenuation and the bass boost so that they will complement the characteristics of the particular record we are playing at the moment.

Many amplifiers and radio-phonographs have tone controls. These are *not* equalizers. They cannot adjust the points in the frequency range at which the emphasis and attenuation begin; they can adjust only the amount of rise and fall, always beginning at the same point. While tone controls can give a rough approximation which satisfies some ears, a more exact method is required for really good results. And the only way to achieve it is to provide multiposition rotary switches, each step of which selects a special circuit which has been designed for correct equalization.

Very few systems provide for step-type bass equalization. Ordinarily only custom installations are so equipped. The writer's preamplifier has separate bass and treble equalization switches, with a total of twenty calibrated combinations. However, almost all preamplifiers including the GE and Pickering, have fixed bass equalization which is a good match for most American records and for London LP's. Beginning at 500 cycles per second, the output voltage doubles each time the frequency is cut in half—a rise of 6 db per octave with decreasing frequency. Some, unfortunately, do not carry this scheme to a low enough frequency—ideally, about 10 cps should be the lower limit. Most units carry equalization down to between 50 and 100 cps, which is in many cases a satisfactory compromise unless the ultimate in good reproduction is sought. European records require less bass boost since their dropoff begins at 250 cps or thereabouts. As a result, they often sound "boomy" when played through the usual system.

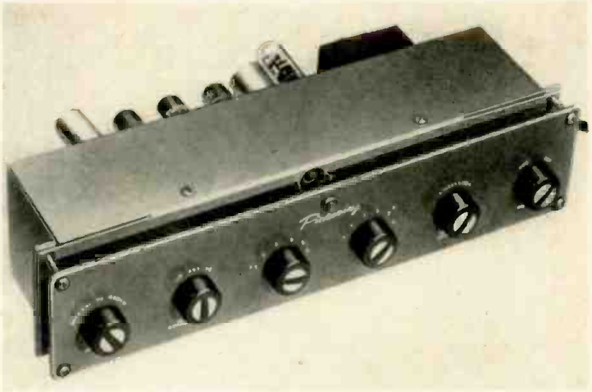


Fig. 6. Typical of complete control units is the Pickering Model 410 Audio Input System, which has volume and tone controls in addition to preamplifier.

Fig. 5. In order to match the pre-emphasis used by most record makers, the Pickering 132E Record Compensator can be connected between Pickering pickups and the preamplifier.

The Pickering Model 132E Record Compensator, *Fig*. 5, does a good job of equalizing in the treble range. It has a rotary switch with six positions, each of which is a satisfactory match for certain records. As the photo shows, the record types are indicated on the dial. The Record Compensator is inserted between the pickup and the preamplifier. The cable from the pickup is plugged into the connector on the left side of the case and the cable from the Compensator is plugged into the preamplifier. The shortest possible lengths of cable should be used in any system of this kind; longer lengths cause loss of high-frequency response. The Pickering Compensator may be used with any preamplifier which has an input resistance of 47,000 ohms. The GE units have a lower input resistance, but any serviceman can replace the 6,800-ohm input resistor with a 47,000-ohm resistor. The Pickering preamplifier is supplied with the correct resistor. The Compensator will not, however, equalize correctly for any but the Pickering cartridges.

An interesting and useful unit is the new Pickering Model 410 Audio Input System. This unit contains a preamplifier, a step-type equalizer, and all necessary controls for an entire installation.

The first rotary switch selects either phonograph, television (if an audio takeoff is provided on the TV set), or radio tuner. Only the phonograph pickup is put through the preamplifier. The second control selects one of three high-frequency record-equalization characteristics, including, incidentally, the standard playback curve of the Audio Engineering Society. The next two controls are step-type bass and treble tone controls. The fifth is a volume control and the last is an on-off switch for the entire system, including amplifier and turntable.

The question of which pieces of equipment to select are dependent on how much money there is to spend and what any individual likes best. The former can be decided without any help. The latter should be resolved by listening tests. At least in the larger cities, more and more audio salesrooms are equipped to demonstrate these and other units, with pick-up-equalizer-preamplifier-amplifier-speaker combinations as desired. There is still no better way to reach a decision than to listen with both ears.

ERRATA ETCETERA

NUMEROUS eagle-eyed readers have noted a few errors in past issues which have heretofore escaped detection by the pseudo-eagle-eyes on our staff. For the record, and with the suggestion that readers make suitable notes in the issues involved, here are the corrections.

In O'Brien's article, November 1951, no mention was made of the switch S_4 and capacitor C_{14} at the output of the unit. This switch, when closed, provides a fixed amount of high-frequency roll-off, approximating that required for the AES curve, although not quite sufficient for this purpose. If complete correction were desired, the capacitor C_{14} should be .0013 µf. However, the input capacitance of the power amplifier, together with the shielded connecting cable must be considered in determining the roll-off. These two capacitances may be considered as being indigenous to the power amplifier, and should be lumped together in making calculations.

In the continuously-variable-turnover preamplifier described by Jones in the January issue, the capacitor shown as .001 from the cathode of the 6C4 to the variable resistance R_3 will give turnover frequencies which are much too high for commercially available phonograph records. The amplifier as shown would be more useful for a tape playback amplifier than for record reproduction. If, however, the capacitor had a value of .005 µf, the range of turnover frequencies would extend from 1100 cps down to 250 cps, and would be better for phonograph use.

Last, but not least in the recent history of errors, is the transposition of *Figs*. 8 and 9 on page 15 of the February issue, in the Toth article. This is reasonably obvious to the reader, but is here mentioned to indicate that we are regrettably aware of the misup.

To our observing readers, orchids; to our unobserving proofreader, a series of brief but effective "tch-tch's."


Purity of bass down to 30 cps
WITH THE NEW
KLIPSCH LICENSED
EV
Royal
FOLDED CORNER HORN ENCLOSURE
Designed for 15" Coaxial Speakers and 800 cps Separate 2-Way and 3-Way Systems
Reproduces the lows with unprecedented efficiency. Laboratory flatness ±5 db to 30 cps. Upper register response more pleasing, too, because of proper over-all musical balance. Authentically styled, amazingly compact, and moderately priced.
A new musical experience awaits you . . . in the ROYAL. Hear lows you can literally feel! This beautiful corner cabinet employs the walls of the room as an extension of the exponential air load on the driver. Designed for 15" coaxial speaker, or for 800 cps separate 2-way and 3-way systems without modification. Listen to the ROYAL at your E-V Distributor, or write for Bulletin No. 183.
The ROYAL—Another E-V First!
Fits beautifully in any room. Exquisite veneers in hand-rubbed lustrous Heirloom finish. 37" high, 20½" deep, 23¾" wide. Net Wt. 69 lbs. Shpg. Wt. 79 lbs.
Mahogany. Less Speaker. List Price..$180
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The ARISTOCRAT
Popular low-cost E-V folded corner horn enclosure for single 12" full range speaker 29½" high, 16½" deep, 19" wide.
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HI-FI SPEAKER SYSTEMS • MICROPHONES • PHONO-PICKUPS • TV BOOSTERS • TV DISTRIBUTION SYSTEMS
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RECORD REVUE

EDWARD TATNALL CANBY*

How I Fell Into Audio

This is going to be a species of biography—but first an aside. This department sometimes finds itself in a curious dilemma—everybody in records and audio is out shouting his head off about the latest sensation to hit the Big Time (Tape in the Home, maybe, or Hi-Hi Custom Installations . . .) and we seem in a mood, here, to stand by, just a bit bored. The reason? Merely because, time and again, our bolt has already been shot, back when no one was interested and we were aiming high, perhaps blind, and too soon.

Bad timing, perhaps. We didn't wait for the psychological moment. But, after all, somebody's got to say, "hey, look over *here!*", when nobody wants to look over here because Publicity's searchlight is spotting elsewhere.

Anyhow, if some of our new readers—especially the hi-fi converts with all their enthusiasm—find us occasionally off, instead of on current publicity bandwagons, well, maybe we are. We try to get ahead. But just take a look through the back issues. End of aside.

Falling into Audio

Well, then, how *do* you get ahead of time (and we'll stand on our record there)? In particular, some may wonder what led this individual musician, wholly trained in music, no engineer, into the surprising position of a guy who is supposed to Know What's Coming Next in records and audio.

At this point I can't help knowin' it—they throw it at me right and left. I'm as likely as not to hear about a good thing very early in the game. The mechanism of getting ahead-of-time information is simple enough. But, if I do say so, it takes a kind of attitude of mind, and a variety of enthusiasm for new possibilities and, maybe most important, a habit of picking up basic principles from all sorts of casual and everyday happenings such as almost anyone dickering with music on records might have.

Herewith, then, a first installment of pussonal experiences that had this very effect on me, 'way back. Things that made me topple slowly but surely, but with surprising inevitability, into the present area, bridging the technical and musical aspects of recorded sound. Engineers may be amused or horrified; some of the lay brethren may exclaim, "Why, *I* did that too!" As far as I'm concerned, the whole "audio" development, hi-fi and all, and the spread of recorded music, has been in the cards for twenty years at least. Nothing more than elementary common sense, given a few basic facts and situations. Anybody could have seen it coming. I did. But I didn't study all this up, consciously. Not a bit. I just fell into it. What astonishes me is that everybody else didn't fall in too. Here's how.

Year One—Wrong Tune

The Year One finds me, maybe aged 6, with a fine, circular toy metal Victrola, painted orange, with slots in the sides. Mommie gave me Mother Goose records from the Five and Ten and I played Popular Favorites too. My nurse, the so-and-so, warned me that if I was naughty, the Victrola would play the wrong tune; that had me in a state of mind for weeks. I was horribly afraid that, one day, the thing wouldn't play "Over There" (Caruso—"Johnnie get your gun, get your gun, get your gun . . .") when I wanted it to. I began to wonder, right then, just what it was that made a Victrola emit music. Of course I definitely had no idea this was *reproduction* of sound—a conception a bit beyond youngsters of that age. The machine talked, or made its own music—I called it "Victrola-music"—and that was that. If it wanted to change its tune, surely it could.

Scene Two (skipping lightly onward) *circa* 1927, discloses a Prep School liberally equipped with Orthophonic Victrolas. Wow! They played Franck and Brahms Symphonies to us and Bach-Stokowski, soon after.

One Sunday our ardent music teacher hauled the biggest Orthophonic up into the balcony of our dining-hall-chapel and we had the Philadelphia Orchestra, floating through the stonework, for our musical prelude. That was my first experience with Distributed Sound Source, the root of many a later (and continuing) experiment in loudspeaker placement. Bach-Stokowski, echoing through a stone building from no one knew just where, was so overwhelmingly more effective than the sound of the same record on the same machine in our uninteresting little class room, that I realized an Idea had been born in me. I've been fussing with it ever since. Lesson 1.

1930—Artificial Echo

Went to college—Yale, for a year—rented me a portable phonograph, bought my first records. One day, somehow or other, I got the zany idea of playing two pickups on one record! Took off the electric pickup of my machine and tracked it right behind the acoustic one of somebody else's machine. We were most gratified at the huge volume and expansion of the music (all relative, of course) but I was vastly intrigued, being a real crackpot experimenter, with the "echo" we got when one needle traced a couple of inches behind the other. Many times I tried it again, later, to see what crazy effects I could get, and I found, of course, that an almost natural impression of what we'd now call increased liveness was possible.

Never took it seriously, though. I didn't take any of this seriously. Just a lot of kid stunts. (We also tried every variety of off-center hole, just like other kids. Wasn't until the little twist-starting motors came along, later, that we managed to run a record backwards. Was *that* a happy discovery!)

1932—The Machine, not the Records

I moved on to Harvard, and roommate and self splurged on a second-hand RCA console. Bulbous protuberance where the speaker was mounted. A weird radio tuning handle that reminded me of a tongue stuck out between horrid, grinning stretched lips. (*Must have been an RE-45.* Ed.) We bought the entire set of Ansermet Handel Concerti Grossi and the huge Brunswick gold-label album of Beethoven's Missa Solemnis. Were *we* highbrow. Too highbrow—we returned 'em. But the sequel was interesting. I kept a few of the Handels (still have them) because I liked the music, though we had decided they were hopelessly defective because the bass notes broke up so badly that the music was hash.

Come spring, we traded in the RCA on

[*Continued on page 40*]

* *279 W. Fourth St., New York 14, N. Y.*

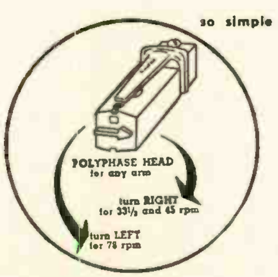
In music, listening quality is everything

that's what the man says...

"... In music, *listening quality* is everything. My CHROMATIC POLYPHASE has that quality to a degree that I never thought possible. More than that—for the first time, I am now able to test-play a soft master-disk without damaging the groove-walls. I am thrilled with its performance. . . . By the way, after many comparisons, I have decided to use the AUDAX H-5 CUTTER exclusively. . . ." *So says the violinist (Toscanini's NBC Symphony) of "Musician's Amplifier" fame.*

For years, Weil has been preaching that in reproduced music, listening quality is everything, just as it is at the actual concert. If the quality is present, you may be sure the range is there also. The reverse, however, is seldom the case.

Never before such EAR-QUALITY, such FAITHFUL REPRODUCTION, but . . . after all the reams are written about kilocycles and other laboratory data—when the chips are down—YOU and only YOU can decide what sounds best and most pleasing. Therefore . . . SEE and HEAR POLYPHASE and—YOU be the judge.



One single magnetic unit plays all home records—Sapphire or Diamond styli.

Special models for radio stations, including Vertical-Lateral units.

with the new Compass-pivoted Audax arms and for Record Changers.

Write for editorial reprint on POLYPHASE Principles

Be sure to obtain a copy of PHONO FACTS from your distributor

AUDAK COMPANY

500 Fifth Avenue New York 18

"Creator of Fine Electro-Acoustical apparatus for over 25 years."

a more modern (1931) model. Lo and behold, the records sounded fine. So it had been the machine that was wrong, not the records. A simple thing, but a lesson I'll never stop preaching.

A cardinal point in any man's phonographic roster of common sense, now as then, is to blame the record *last*, not first. How many do it! We've been going off the track regularly on this score ever since. (I'm still getting complaints about LP records that "don't track," for instance, when it is long since obvious that the fault is in the playing arms 99 per cent of the time.)

That summer I was treated to the extreme reverse of the Distributed Sound experience. This clinched it. Went to the Concord Summer School of Music, where one hot day in a high school gym we were presented with a lecture on the Bach B Minor Mass—illustrated. The dear professor, so musical, so utterly unmechanical (he treated phonographs the way horse-minded grandpa approached the horseless carriage), gave his talk, then pulled a monster Electric Victrola out on the stage at one end of the gym, planked it right on the edge, aimed squarely in our faces, and turned up the volume. I shall never suffer a more hideous "concert," I'm sure.

There and then, the very hard way, I discovered the musical Point Source Effect, which I was ever afterwards to avoid, in devious and various ways!

I've given many a phonograph "concert" since, but not once has the speaker ever been aimed directly at an audience, without some form of interference to "break up the beam." Our newer systems, horn and otherwise, do much to meet this trouble automatically, but the principle remains and I still prefer a sidewise or rearwards speaker aim, using reflection, if I can possibly manage it.

1934—Intimations of Hi-Fi

How did I discover "hi-fi?" You define that word and I'll tell you. But I keep moving backwards in time, as I think along, to some earlier revelation that might be, for me, the Beginning of an interest in modern quality reproduction.

In 1934 certain gaudy and flamboyant mail-order ads reached my college door and neatly trapped me. "Buy this Super-Ultra-Incredible radio by mail, at a fraction of retail cost! *Sixteen* tubes (that slayed me), 29 shortwave bands (or almost), Magic Color Tuner with 8 sets of colored lights. . . ." I fell.

But by some bit of unusual prescience I had the sense to fall even further. For $15 extra I ordered an ultra-fancy speaker, installed free, that would add the last touch of superb realism.

Astonishingly enough, it did. That speaker kept me blissfully happy and well ahead of Competition for a good five years, before it was junked. You may laugh at my naiveté, but the thing was fantastic, a revelation and a local sensation. The sound of my records (with the mail-order set's fairly good audio as I now realize) was so amazingly better than anything we had ever heard before that I went around for days in a delirium and practically never turned the thing off. People came from far and wide. (To be specific it was a Wright DeCoster 12-in. electrodynamic heavy-duty, "specially designed." Probably took a good 10 or 15 watts.)

By almost-accident, then, I'd discovered dramatically, for the first time, the value of a quality separate-unit component and the importance of a good speaker. By another bit of prescience, I'd also acquired a fine RCA record player attachment, two-

speed, one of the very first ever made. Straight-arm horse-shoe magnet pickup, guaranteed to track perfectly at 8 or 9 ounces. With new pickups, it followed me around for years—another useful separate unit.

Around 1940, when I'd long since been deeply involved in a new and separate amplifier, the old speaker was finally junked after some abortive attempts to add a sort of "tweeter" arrangement via some 50-cent miniature speakers. (See—I'd begun to hear about highs. . . .) It had done its job all right, for by that time it was a vital part of my power supply filter. The thing was so solidly built I never did figure out how to get the coil out of the frame, and so it sat on its rear under my kitchen sink, filtering rectified a.c. for another couple of years before it departed for good. Worth 15 bucks extra? You bet.

Thus did High Fidelity in a basic sense, better sound reproduction, enter my life with a succession of loud noises. It was only 1934, but I'd already caught on to the principle that if you buy better equipment, buy separate units, you'll get better, cheaper reproduction. Seems I was well ahead of the game, to put it mildly. But I didn't even know it.

Try these on your hi-fi equipment

(Note: As in earlier listings, these combine hi-fi on the technical side with good miking for the type of music and adequate performance. Code symbols add details.)

Key

* Outstanding recorded sound for the type of music. [a] Unresonant, deadish acoustics. [b] Big bass. [c] Close-to highs with sharp edge. [d] Some distortion in highs. [f] Flattish high end; needs boost over normal playback. [o] From older 78 disc issues. [p] Piano is tinny, metallic. [v] Violin solo very close, big. [x] Will need bass boost over normal LP playback.

Big-orchestra stuff—light

Leroy Anderson Conducts, vol. 2. L. Anderson & His "Pops" Concert Orch. **Decca DL 7519**

Do I detect a trace of hard-boiled Kostelanetz-Gould stuff in this, added to Anderson's former delightfully warm, uncomplicated old-fashioned style? Has ye juke-box had its deadly effect on Anderson's spontaneity? Hope not.

[c]* **Rossini-Respighi: La Boutique Fantasque.** Royal Opera Orch., Rignold. (Sadler's Wells). **Decca DL 7518** (10")

Pineapple Poll. a) Sadler's Wells Orch., Mackerras. [f] **Columbia ML 4439** b) Royal Opera Orch., Lanchbery. [cd] **Decca DL 7521** (10")

Gilbert & Sullivan ballet—though the Decca is the crisper and livelier, the LP is a wee bit hard on the ears; the relatively stodgy sound of the English EMI (Col.) is actually cleaner, though unspectacular. (Col. has more music.)

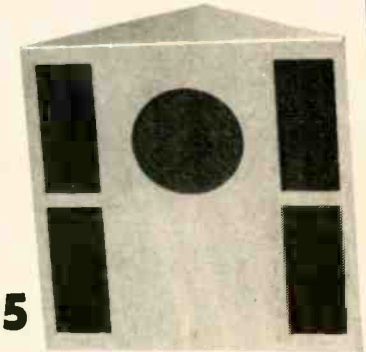
[c]* **Famous Overtures—Offenbach.** London Philharmonic, Martinon. **London LL 350**

[c]* **"New Year" Concert.** (Strauss Waltzes). Vienna Philharmonic, Krauss. **London LL 484**

This department is again receiving Londons after 7-month hiatus. "Ffrr" technique is admirably standardized—these have the expected big, live sound, the string highs very close and edgy. Still a wonderful sound, but not the only style of "hi-fi" acceptable.

HARRISON AUDIO SHOP *features...*

Cabinart FOLDED HORN CORNER ENCLOSURES



These compact, correctly proportioned Cabinart corner speaker enclosures will extend your bass response a full octave, with no cabinet resonance peaks!

Assemble it yourself in less than an hour, and save $30.00! Only a screwdriver needed. Complete packaged KIT of precut and smoothly sanded solid 5 ply welded wood plus plastic grille cloth; all hardware, KIMSUL Acoustic insulation, plastic wood, glue and simple assembly and finishing instructions.

For 12" Speaker: 32½" wide x 32" high x 16" deep. 26 lbs. Model 61 — **$19.95**

For 15" Speaker: 34" wide x 32" high x 17" deep. 28 lbs. Model 63 — $23.95

Also available completely assembed, with beautiful hand-rubbed finishes. Write for literature.

Using a Williamson ?? Double your power output, and reduce distortion by 50%!!

Use an ACRO TO-300

"The World's Finest Transformer," — and convert to Ultra Linear Operation by simply changing three* resistors and condensers!

- Response ± 1 db 10cps to 100,000cps
- Rated to handle 40 Watts
- Resonance-free response
- Unequalled square wave response
- Low phase shift
- Most quality per dollar!

ACRO TO-300 — **$24.75 net** *Conversion Kit — $1

ACRO TO-310 — Same ratings but 20 watt. For converting all popular 10 watt 6V6 amplifiers to the sensational Ultra Linear Operation — **$18.75**

FREE! Write for 12 page ACRO data; Amplifier and conversion schematics.

ACRO TO-290 for the Original Williamson Amplifier. Performance equal to the finest — regardless of price! $15.75

All units fully potted in attractive grey hammertone case. Compact, only 3⅝" x 3¼" x 4¼" high.

Harrison Has It!

KT-66

Plug a pair of these famous OSRAM KT66 tubes in your 6L6 sockets and, without any circuit changes, enjoy less distortion in your output! Can deliver 50 watts in continuous service, with longer life. Ideal for the Ultra Linear amplifier.

Harrison Has Them for only **$3.97** each

Special Value! Filter CHOKES

High quality, conservatively rated for continuous duty. Potted in metal cases for upright or inverted mounting. Lugs. Ideal for all amplifiers.

PA-100 12 Henry at 10 MA. 15 ohms. 3" x 4½" x 4½" high.
$11.00 List value Special **$3.49**

PA-48C 75 Henry at 50 MA. 2500 ohms. 2½" x 3" x 3" high.
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Hear your Ultra Linear (or any amplifier) at its best with a

WHARFEDALE SPEAKER

Smooth 30 to 18,000 cycle response. High efficiency 12 watt power rating. 18¼ lbs! 15 ohm VC. Exclusive cloth suspended cone minimizes transient distortion and "boom".

SUPER 12/C.S./AL

Really worth more but Harrison sells it for only — **$61.95**

PUNCHED CHASSIS *for Williamson*

Take the work out of building your Williamson with these completely drilled chassis for amplifier and for power supply. 7" x 9" x 2". Grey hammertone finish.

Both for only **$5.75**

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227 GREENWICH ST.
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cd **Delibes: Sylvia; Weber: Inv. to the Dance; Ponchielli: Dance of the Hours.** Roy. Op. Orch. Rignold. **Decca DL 9549**

Again, would be a top hi-fi sound, with sharp, edgy highs, except for some distortion in the LP transferral, not-too-good surface. A close miss—other pressings may be better.

Curtain Time. Morton Gould & His Orch. **Columbia ML 4451**

Big, live sound, the arrangements, with G. at piano, mostly stringy, slick-smooth; hence not hi-fi-spectacular.

* **Tati-Tati. (Symph. Paraphrases on Chopsticks).** Col. Symphony, Janssen. **Columbia ML 4480**

If you haven't got this—own it! Superb recording job in every way and most entertaining as well. (19th C. Russian composers.)

x **Waltzing with Waldteufel. Strauss Polkas, vol. 2.** Boston Pops Orch., Fiedler. **RCA Victor LM 1226**

Ye old story—use full bass boost and this sounds roughly like others with normal bass. Sharp, good high edge, rather distant pickup.

Gershwin: An American in Paris. odt **Rhapsody in Blue.** Andre Kostelanetz & His Orch., Alec Templeton, piano. **Columbia ML 4455**

Big Concerto Style
x **Liszt: Todtentanz** (Dance of Death).
x **Franck: Symphonic Variations.** Brailowsky; RCA Victor Symph., Reiner; Morel. **RCA Victor LM 1195**

Tremendously noisy Liszt Variations on the ominous chant, "Dies Irae," with hard, skeleton-like pianism from Brailowsky. The Franck is hardly as juicy as it should be, lacks the proper perfume.

ax! **Rachmaninoff: Piano Concerto #3.** Horowitz; RCA Victor Symphony, Reiner. **RCA Victor LM 1178**

Full bass boost on this still leaves the lower end thin sounding! Why? This piece is mostly piano—the orchestra hardly breaks through. Rather muffled sound, the piano big but somewhat metallic.

dv **Brahms: Violin Concerto in D.** Peter Rybar; West-Austrian Radio Orch., Moltkau. **Concert Hall CHS 1113**

The smaller outfits now are invading the big-time symphonic field; they are unwise. This kind of music takes top stars, the biggest conductors and fanciest orchestras, to match the expected performances known already so well. This job is distinctly under that sort of par, both in the playing and in the recording set-up.

(d)* **Tchaikowsky: Piano Concerto #2.** Mewton-Wood; Winterthur Symphony, Goehr. **Concert Hall CHS 1125**

d* **Tchaikowsky: Piano Concerto #3, Op. 75; Concert Fantasy, Op. 56** Mewton-Wood; Winterthur Symphony, Goehr. **Concert Hall CHS 1126**

Different story here; none of these is commonly heard and the performances, though a bit ragged, are good. Excellent basic miking and fine balance, good piano, but loud parts are somewhat distorted in the 2nd Concerto and badly distorted in the 3rd-Concert-Fantasy record. Something sadly overloaded. (Probably on original tape, alas.) Other pressings just might be different—worth a try, since the music is interesting and novel.

Some Mozart and Haydn
c **Mozart: Sinfonia Concertante (Double Concerto) for violin and viola, K. 364.** W. Barylli, vl., Paul Doktor, viola; Vienna State Opera Orch., Prohaska. **Westminster WL 5107**

Probably the most brilliant hi-fi Mozart record made so far—and one of his most wonderful works to boot. A terrific string brilliance here, but without distortion, the highs close-to, yet in a big, golden liveness, the solos ideally balanced with the orchestra, the whole a scintillating, jewel-like effect of glittering realism.

Haydn: Symphonies #99, #101 ("Clock"). Vienna State Opera Orch., Scherchen. **Westminster WL 5102**

Hi-fi-ites will know at least a half-inch—those famous drums—of Scherchen's first LP in this series! Those who have played the rest of the record (an excellent indication, *ahem*, of where your heart lies) may be delighted by this latest, the fourth. Scherchen is doing a powerful revaluation of these late-Haydn symphonies, bringing out in them both a strong, virile Romanticism that has long been out of style, Haydn being by old convention, "Papa" Haydn and all frills and furbelows, and at the same time showing, with tremendous recording to help, that Haydn also retains very much of the splendid, brilliant, massive sound of the Baroque (Bach) period that came just before. Makes a big difference—too long these have been treated as cute little virtuoso concert curtain-raisers. Nobody could think them that in these stunning recordings! Try also #103, on WL 5050. Only possible rival technically to these is London's "Clock," and others, on ffrr.

Mozart: Piano Concerto #25 in C, K. 503. Carl Seeman; Munich Philharmonic, Fritz Lehmann. **Decca DL 9568**

The masterly touch of Lehmann (Lotte's brother) makes the orchestral part of this solid, unhurried concerto a delight, and Carl Seeman's light-footed, rather staccato piano is good too. Nice record, though due to modestly distant pickup and Seeman's quiet piano it won't bowl over the tin ears. Variations on Gluck theme (piano alone) are an amusing addition, to fill out side 2.

Haydn: Symphonies #94 ("Surprise"), #103 ("Drum Roll"). Royal Philharmonic, Beecham. **Columbia ML 4453**

Contrast this Beecham Haydn, best of the older style interpretation, with the above Scherchens. Musically ultra-accurate, but rather complacent, too arch, with a big-orchestra sound that is muddy, rather than impressive. Recording is good average, impeded (for our machines) by unboosted British highs, extra bass (300 cps turnover?). Adjust accordingly.

Mozart: Divertimento #7 in D, K. 205; Cassation in B Flat, K. 99. Salzburg Mozarteum Orch., Paul Walter. **Period SPLP 528**

"Incidental" or "background" music, cross between orchestra and "chamber" style and a type to get to know. K.205 is for small string orch. and two horns, the early (aged 13) K.99 for same plus two oboes. Both have very lovely melody, unobtrusive charm. Musical, if a bit unevenly played; some distortion (a bit of noise modulation, somehow) but won't bother you much.

Mozart: Wind Serenades #11 in E Flat, K. 375, #12 in C Minor, K. 388. a) Kell Chamber Players. **Decca DL 9540** b) Members Vienna Philharmonic. **Westminster WL 50-21**

More of same, all wind, and a lovely sound when you get used to it. Two superb jobs, same two pieces. Decca's (Kell) is smoother, more polished, the Vienna Westminster playing slightly more plastic and colorful; both are tops. Decca is lower level, bit less well defined, but good. Note Westminster has had this re-cut from original tapes, with considerable improvement. Look for "xtv" (Columbia processing) on new edition's record face.

Mozart: Piano Sonata in D, K. 576 ("Trumpet"). Wm. Schatzkamer. **RCA Victor LM 156 (½ 10")**

Mozart: Piano Sonatas in C, K. 279, in F, K. 280. Florencia Raitzin. **R.E.B. #4**

A puzzle to many, pianists as well as listeners, the Mozart sonatas are "explained" when you understand that they were never intended for our modern piano but for a smaller, yet more brilliant instrument, with a slivery, twangy treble and a soft, harp-like bass. Modern players must avoid loud, swaggering playing, yet somehow achieve the brilliance and fullness of the harpsichord-like original. Almost impossible, without imagination on the listener's part! Schatzkamer does an average, amiably so-so job on his part, with a bit of the usual feeling that these are a sort of miniature "exercise," which they decidedly are not. Raitzin, with great advantage of training under Landowska, may sound thin and distant—but close listening shows up a superb shaping and accuracy of detail.

If you want to hear the actual Mozart piano—a lovely thing—try this, by a composer, American-German, who might be Mozart himself for all most of us can tell. Same style of careful playing, on the actual Mozart instrument:

Reinagle: Sonata for Early Piano. Arthur Loesser, piano built (by Challis) to duplicate piano of 1790-1800).
New Records NRLP 2006 (½ 10")

EQUIPMENT REPORT

[*from page 30*]

with five different characteristics being provided. Two characteristics are available for the radio inputs, the AM position having a roll-off to reduce noise in locations remote from broadcasting centers. However, AM radio can be played in the FM position, if desired, since there is only one input for radio, the switch selecting this input on two positions—one marked FM with flat response, the other marked AM, with the high-end roll-off. Tone controls are well designed, and have a definite center position for flat response; the volume control is compensated for low-level reproduction. Listening quality is excellent on both radio and phono, and the operation of the selector-equalizer switch is simplified enough for the non-technical operator.

The following table shows the signal voltages for the various inputs for an output of 1 watt:

SIGNAL INPUT VOLTAGES for 1-watt output
(1000 cps, volume control maximum, tone controls "flat")

Input	Selector	Voltage
LO Radio	FM	0.18
HI Radio	FM	1.2
LO Radio	AM	0.22
HI Radio	AM	1.4
Crystal PU	LP	0.36
LO Mag PU	LP	.0036
HI Mag PU	LP	.011

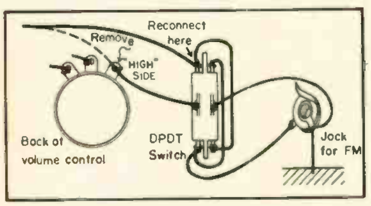
Audio in the Home

William C. Shrader*

A complete home music installation should include some kind of radio tuner, if sufficient versatility of entertainment is to be had. While many users will already have a good AM tuner, and will prefer to retain it as the basis of the radio section, it may be desired to add an FM tuner somewhere in the installation.

The physical mounting of the tuner is a problem which will have to be solved by each individual, for it depends largely on the availability of space. If a separate speaker is to be used, it may be possible to locate the tuner in the speaker compartment which has then been vacated, even though it may not be convenient to tune.

Electrically, the problem is a bit simpler, because many of the later sets have FM or TV jacks on the back, and are usually provided with a switch to select the program source. If there are no jacks, one may be installed, together with a double-pole-double-throw (DPDT) switch—one circuit switching the signal lead and the other shorting out the unused circuit. This may be done by removing the head from the "high" side of the volume control and connecting it to one of the outside contacts of the switch, as shown in the figure. The lead from the new jack is connected to the other outside contact of the switch,



and the arm is connected to the volume control terminal from which the lead was removed. The other points on the switch are connected as shown, and the switch then serves to short out the AM signal when listening to FM, and vice versa. Cloth- or rubber-covered shielded lead should be used for this wiring, with the shield connected to the chassis. If the FM set must be mounted at any great distance from the radio, low-loss microphone cable should be used for the connection to prevent the loss of high frequencies due to the added capacitance of the cable.

Further "solutions" to the problems encountered in the search for good music reproduction will be discussed in this section next month.

Addition of jack and DPDT switch and wiring changes shown will permit selection of either AM or FM tuner with minimum of effort.

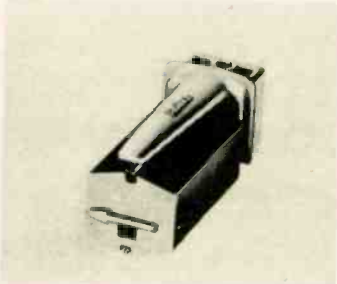
*2803 M St., N. W., Washington 7, D. C.

NEW PRODUCTS

• Sealed Selenium Rectifier. Quick Replacement and effective protection against moisture, fungus, and corrosive atmosphere, are features of a new line of miniature selenium rectifiers recently intro-

duced by International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif. The new units are sealed in metal cases filled with inert gas and are fitted with standard tube-socket bases. Complete engineering and application data will be supplied upon written request to the manufacturer.

• Improved Audak Cartridge. Virtual elimination of needle talk and the record wear of which it is a symptom have been accomplished in the new Audak Chromatic Polyphase pickup. Successful attainment of near-zero mass and near-infinite compliance assures complete groove control over stylus movement. According to the manufacturer, even soft master discs can be played repeatedly



with the Chromatic without perceptible wear. The unit is supplied as a turnover-type cartridge with sapphire for playing standard 78's and diamond for playing LP's. Literature will be mailed free by The Audak Company, 500 Fifth Ave., New York 18, N. Y.

• Economical Turntable Assembly. Introduced to meet the demand for a moderate-priced single-play turntable stimulated by the growing popularity of LP records, the

new Garrard Model M is sturdily constructed around a heavy-duty four-pole motor which offers exceptional freedom from both hum and rumble. Also equipped with weighted turntable and the Garrard "parallel lift" tone arm. The Model M is supplied as standard with interchangeable plug-in shells, similar to those supplied with the Garrard RC-80 record changer, making it possible for the purchaser to use the crystal or magnetic cartridge of his choice. Further details will be supplied free upon written request to Garrard Sales Corporation, 164 Duane St., New York 11, N. Y.

• High-Quality Speakers. Illustrated below is Model CO12JB, a co-axial 12-in. speaker representative of the new line of wide-range units recently introduced by Oxford Electric Corporation, 3911 S. Michigan Ave., Chicago 15, Ill. Other models range in size from 8 in. to 12 in. and in power handling capacity from 10 to 25 watts. Voice coil impedance of all

models is 8 ohms. The CO12JB is a 10-watt unit and has a frequency range of 65 to 15,000 cps, with crossover at 4000 cps. Designed for eye as well as ear appeal, the new Oxford speakers are attractively finished in two-tone hammerloid. Available now through many leading jobbers. Illustrated literature will be mailed free upon request to the manufacturer.

• High-Quality Tape Recorder. Superb audio quality, portability, and push-button operation combine to make the new Ampex Model 400-A an ideal unit for discerning homes, or for application where highest professional standards prevail. Available

for either half-track or full-track recording, the 400-A can be operated at either 7½ or 15 ins./sec. as controlled by a speed selector switch. The Model 400-A differs from the earlier Model 400, which it supercedes, in the fact that all mechanical motions are operated by solenoids under push-button control. Starting interval is 0.1 second. Frequency response is down no more than 4 db at 30 and 15,000 cps at 7½ ins./sec., and within ± 2 db 50 to 15,000 cps at 15 ins./sec. Noise level is 55 db below the 2 per cent total harmonic distortion level. Full information will be supplied by Ampex Electric Corporation, Redwood City, Calif.

• Preamplifier - Equalizer. Recommended compensation for all types of recordings is combined with a high degree of flexibility in the new Brociner Model A100 preamplifier-equalizer. Operating controls provide positions which cover the original Columbia LP curve, the RCA-Victor LP curve, both old and modern 78-r.p.m. discs, and AES and NAB settings. Supplied with the unit is a list of recommended settings

for various makes of records. Independently adjustable turn-over and roll-off controls permit 24 different frequency characteristics. The A100 is a three-stage triode amplifier equipped normally with an adapter power plug which fits under beam-power output tubes. Triode adapter available on request. Model A100P contains integral power supply. Both models are supplied with brushed-brass designation plates for front-of-panel mounting. Brociner Electronics Laboratory, 1546 Second Ave., New York 28, N. Y.

• Heathkit Williamson-Type Amplifier. Audio enthusiasts with whom economy is an item which must be considered along with quality will be enthused over the newest "Heathkit" — a Williamson-type amplifier complete with power supply and preamplifier-control unit. Priced remarkably low, the amplifier follows closely the circuit of the Musician's Amplifier, described originally in the November, 1949 issue of Æ. The preamplifier contains three input channels, two low-gain for crystal pickup and tuner, and one high-gain with equalization for magnetic pickup. Selector switch provides choice of turnover for 78 r.p.m. or LP recordings. Bass control permits up to 15 db boost or cut at 20 cps, and treble control provides up to 15 db boost or cut at 20,000 cps. Frequency response of the power ampli-

fier is flat within one db from 10 cps to 100 kc. Harmonic distortion is less than 0.5 per cent between 20 and 20,000 cps at five watt output. Intermodulation at five watts is 0.5 per cent using 60 and 3000 cps. The Heath Company, Benton Harbor 25, Mich.

AUDIANA

[*from page 14*]

consequently the stylus tends to pull sideways across the groove. By using a bent arm, and so mounting the arm that the stylus overhangs the turntable pivot by a small and predetermined amount, tangency may be improved throughout the arm travel. There remains, however, a force which tends to cause the pickup to move toward the center of the record. The result is that the inside wall of the groove is worn more than the outside.

Aside from the uneven wear on the groove, this side thrust also causes a certain amount of distortion in the reproduced signal, and this is of even greater importance than the wear—for records can be replaced after they become too worn for good quality.

All of the dimensions of the pickup arm and of its mounting are capable of being calculated accurately, and the tracking error—referred to by the Greek letter *alpha* (α)—can be made a minimum over the entire motion of the arm. The remaining distortion, even when reduced as much as is possible practically, still will be of the order of one per cent.

For this reason, the instructions which usually accompany a pickup and arm are quite specific about the manner in which the mounting should be made. It will be noted that the vertical axis of the arm's mounting should be placed at a certain specified distance from the center of the turntable, and in this position the stylus will pass in front of the center pin of the turntable by an amount varying from one-quarter to one-half of an inch. These dimensions are quite critical, and if the user wishes to reduce tracking distortion to a minimum, the instructions for mounting the arm should be followed closely.

The amount of the overhang depends upon the length of the arm and the angle the head is offset. This would appear to indicate that it is most desirable to use a pickup with the arm supplied by the manufacturer, unless it is determined that the arm is designed specifically for the pickup to be used. This suggestion applies only to those pickups which have the offset built into the pickup mounting. If the offset is a part of the arm itself, the instructions accompanying the arm should make clear whether or not the length of the pickup—and consequently the relative position of the stylus and the arm pivot—would make any difference in the mounting dimensions.

In the absence of any specific dimension for mounting, it is possible to determine with a fair degree of distortion-reduction a positioning which will be passable. This is most readily done by affixing a right triangle along the axis of the pickup with the corner directly above the stylus, and with one leg of the triangle extending toward the center of the turnable. By holding he base of the arm firmly against the motor board, and moving it slightly backward and forward, a position will be found where the edge of the triangle deviates a minimum distance from the center of the turntable pin. This will usually result in minimum distortion over the record area.

HORN-TYPE LOUDSPEAKERS

[*from page 23*]

tions with consequent resonances and standing waves. The problem, then, is to *reduce* the magnitude of these resonances to a small value. They cannot be entirely *eliminated* because no horn of practical size can effect a perfect impedance match with the interior of the usual room.

Fortunately, this problem is not quite so serious as it seems. Most horns are used in rooms which themselves exhibit several resonant modes of vibration. The standing waves which result from room resonance are not ordinarily considered objectionable. Actually, horn resonances can be reduced to the point where they are masked by room resonances. When this is done the results are superior to those obtained from loudspeakers without horn loading.

There are three practical ways in which the effects of horn resonances can be reduced in loudspeaker systems. First, the horn structure can be made as large as practicable. Second, two or more rates of flare can be used in different sections of the horn. Third, the horn can be placed in the corner of the room so that the floor and walls will form a virtual horn which extends into the room itself. The last expedient is very effective in increasing the virtual mouth area. In most cases it provides the best possible impedance match between the generator (driver) and load (room).

Practical Considerations

The foregoing paragraphs have shown the most important theoretical considerations which govern the performance of horn-type loudspeakers *once the several design constants have been chosen.* However, it is usually impossible to assign numerical values to the design constants on the basis of theory alone. A loudspeaker is, among other things, an article of furniture and practical considerations of size and appearance must be taken into account as well as acoustical performance. Sometimes compromises must be made in order to fit equipment into available space. It is the purpose of this section to discuss the practical construction of horn speakers. This can best be done by describing the constructional features of two horn speakers built by the writer for which data are available. The two examples chosen for description are quite different in conception and will serve to illustrate the major requirements which must be met in any system. One of these horns is described in the following paragraphs, and the other follows next month.

Several years ago Olson and Massa[3]

[3] Harry Olson and Frank Massa, *J. Acous. Soc. Am.* Vol. 8, No. 1, p. 48, 1936.
Harry Olson, "*Elements of Acoustical Engineering,*" 2nd ed., Van Nostrand, New York, 1947.

described in the literature a loudspeaker employing two horns and one motor. The low-frequency horn was coupled to the rear of the cone and the middle- and upper-frequency horn was coupled to the front of the cone. Later there appeared in the literature a description of the now familiar Klipsch horn which employed the corner of the room in order to extend the dimensions of the virtual horn. The speaker to be described is a modification of the Olson-Massa design and incorporates the room-corner feature. Although the speaker was built several years ago its performance is still considered excellent. It compares favorably with more recent designs which are vastly more expensive. Using the writer's speaker as a prototype, other constructors have built similar units and have reported excellent results.

Figure 2 shows the main constructional features. The eight-inch cone is mounted near the top, secured to a vertical mounting board about half way back from the front of the structure. A short horn extends forward from the cone. Behind the speaker mounting board is the speaker chamber. The low-frequency horn connects to the lower portion of the speaker chamber and the mouth of the horn is at the front of the structure near the bottom.

For the sake of clarity some of the details are omitted from *Fig.* 2 and are shown in *Fig.* 3. (A) in *Fig.* 3 shows

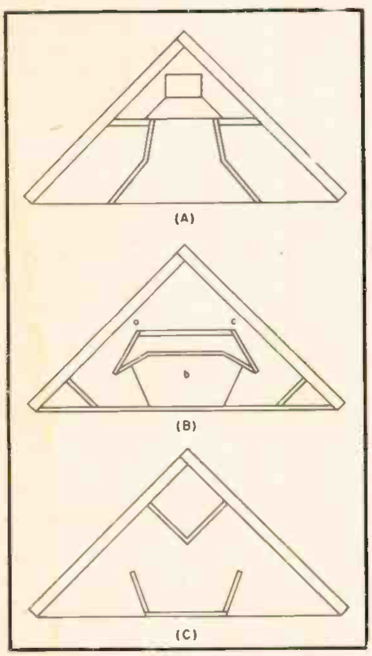


Fig. 3. Details of top (A), center (B), and bottom (C) sections of the duplex-horn speaker.

the plan of the top section of the structure. This section includes the cone, the high-frequency horn, and the upper part of the chamber. (B) shows the plan view of the center section which comprises the lower part of the chamber, the throat, and part of the low-frequency horn. (C) shows the lower section of the structure, comprising the remainder of the low-frequency horn.

The functions of the various partitions can best be explained by tracing the path of the low-frequency horn. As shown in (B) of *Fig.* 3, the throat is in two parts: one half is at *a*, the other at *c*, The first portion of the horn consists of two parallel paths, from *a* to *b* and from *c* to *b*. The paths converge at *b* and immediately pass down into the bottom section through the hole at *b*. The horn then splits into two parallel paths, each of which opens separately at the front of the bottom section, as at (C) of *Fig.* 3.

The effective length of the low-frequency horn is about 45 inches. The total mouth area is about 360 square inches and the total throat area is about 38 square inches. Considerable liberty was taken in the rate of flare in the interest of simpler construction. However, the average rate of flare provides for a theoretical low frequency cut-off at about 52 cps. Eqs. (*1*) and (*3*). This should not be taken too seriously, however, since finite horns radiate appreciable energy at frequencies less than cut-off. This particular speaker, for example. produced fundamentals of 16 cps with considerable intensity. This was the lowest frequency available from the test oscillator. (No claim is made for "flat" frequency response at these low frequencies.)

Interference Effects

It was mentioned earlier that a folded horn does not radiate efficiently at higher frequencies where interference effects exist because of differences in path length. For this reason, the upper limit of the low-frequency horn should be determined before the other horn is designed and built. There is no simple way to compute what this upper limit is: it must be measured after the horn is in operation. A convenient method is to block off the radiation from the front of the cone with absorbing material (pillows, blankets, etc.) and check the operation of the low-frequency horn with an oscillator connected to the driver. Once the approximate upper frequency is determined, the high-frequency horn can be designed to complement the characteristics of the larger horn.

The two vertical boards which comprise the outside "vee," *Fig.* 3 are cut from ¾-in. plywood. The speaker mounting board is made of ½-in. plywood. All other partitions are ¼-in. plywood. All joints are nailed, glued, and reinforced with cleats. A portion of the top is secured by screws to permit access to the cone. The resulting structure is very sturdy. The inside horn surfaces were given several coats of thin shellac and sanded between coats. The resulting surface is very hard. The internal damping of the wood partitions is sufficient to eliminate all but a trace of vibration.

Experiments on this and other units have demonstrated conclusively that the use of thicker wood is no guarantee of reduced horn vibration. One speaker similar to the one described here was built of ¾-in. wood throughout. The vibrations of the horn walls were much more intense for the same electrical input signal. It was necessary to install heavy braces between partitions, and still the braces vibrated. Only by bracing the braces was the problem solved. A clue to the reason came when it was observed that the resonant frequencies of thick partitions were higher than those for the thinner vibrations, other factors being the same. Now, the rigorous theory of vibrating plates is highly complicated but a simpler explanation appears plausible. Consider the following equation for the natural frequency of a simple oscillator:

$$f = \frac{1}{2\pi}\sqrt{\frac{s}{m}} \qquad (5)$$

where m = mass of the vibrating body
s = stiffness factor

In this case the "stiffness" is the reaction of the wood to bending. If we double the thickness of the wood the mass of the body is doubled. However the stiffness of the wood increases much more rapidly than the mass. Consequently, the natural frequency increases: it does not decrease as might be expected. The only advantage gained by increasing the thickness of the wod is the consequent increase in mechanical resistance. Apparently, this advantage is sometimes outweighed by the increase in the resonant frequency *if* this shift means that the resonant frequency is raised from a sub-audible to a value which causes poor transient response in the audible range. It appears

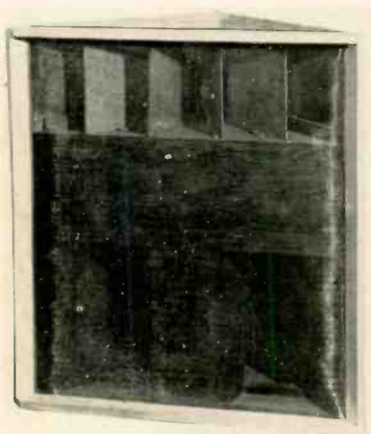


Fig. 4. The completed duplex-horn speaker. Barely visible is the protecting screen which hides the mechanism under normal illumination.

that the most effective way to damp out horn vibrations is to use relatively thin wood and to coat the outside of the horn with viscous damping material to lower the "Q" of the vibrating element.

The only difficulty experienced with this speaker when first constructed along the lines indicated by *Figs.* 2 and 3 was undesired cavity resonance of the Helmholtz type in the speaker chamber. This trouble was effectively eliminated by decreasing the volume of the chamber below that shown in the diagrams. One simple way of doing this is to fill part of this space with sound absorbing material. Another is to block off part of the chamber by the use of additional partitions. The writer employed the second alternative, as shown in *Fig.* 5.

Fig. 5. Speaker chamber in the top section. The plywood partition below the speaker magnet indicates the reduction in chamber volume which was required to reduce cavity resonance.

The front of the completed unit can be covered by a grill to improve the appearance. *Figure* 4 shows a wood frame with bronze screening attached. Thick fabric should not be used, particularly in front of the high-frequency horn because it offers appreciable resistance at the higher frequencies, but Lumite plastic grill cloth may be considered satisfactory. The high-frequency horn shown in *Fig.* 4 is somewhat different from that shown in the diagrams of *Figs.* 2 and 3. The model shown in the photo-graph employs a three-section horn. The two additional partitions were found desirable to increase the dispersion at middle and higher frequencies.

One variation of this design which was brought to the writer's attention deserves mention. It uses a conventional two way speaker with concentric tweeter in place of the single cone specified. Thus, no high frequency horn need be constructed. Reports indicate that excellent performance is obtained in this manner. Since most two-way speakers use large low-frequency cones the total length of the low-frequency horn is lowered for the same mouth area. For dual speakers with relatively high crossover frequencies the action is threefold. The large horn is effective only at the lower frequencies, the middle range is taken from the front of the cone, and the "highs" are obtained from the tweeter.

The second type of horn for low-frequency radiation is a vertical corner-cabinet model which can be accommodated in the average home without too great a domestic upheaval—provided the cabinet-making abilities of the builder will satisfy the distaff department. This model will be described next month in Part II of this paper.

TECHNICANA

[*from page 8*]

nism which turns the equipment on and provides for a warm-up period needed for the amplifiers. In addition to the clock are a set of tubular chimes, striking mechanism, motor drive timing unit, contact discs, timing discs, and cam discs. The three sets of discs provide for the appropriate sequence at correct intervals with such random variation in timing and sound as are peculiar to hand ringing.

The unit may be installed remote from the bell tower with several remote switch positions for sounding bell sequences, and clock control of the Angelus sequence. The accuracy of the unit is plus or minus two minutes which was adequate for the application. Greater accuracy may be obtained, however, using other types of clocks. The one in this unit is a spring driven clock with a rundown time of thirty-six hours, the motor being electrically rewound every eight hours. The size of the dial is three inches. A synchronous clock with standby power would be the next step in improving the performance.

Music-Speech Level Ratios

Results of the BBC tests on switching between speech and music were published in *Wireless World*, December 1950. The tests included engineers, musicians, and the public. Also the tests were used to determine the preferred maximum sound level at which the various groups liked to listen. This was done in order to establish the change in equalization need between the monitor speaker channel and the program channel. Table I shows the preferred levels and Table II the preferred change in level between program material of various types.

TABLE II

Preferred change in level db	
From speech to speech	0
From music to speech	−4 to −5
From speech to loud-starting music	+2
From speech to quiet-starting music	+2 to +3
From speech to interval signal (Bow Bells)	−19

Voltage Regulator Tubes

An article on the use of neon voltage regulator tubes by C. Tuppin appears in the September 1950 *Toute la Radio.* Techniques for the stabilization of both d.c. and a.c. voltages are discussed, and trigger tubes are mentioned briefly. Of importance is the table of regulator tubes available in France. Some of these tubes are capable of stabilizing voltages as high as 340 volts while others have current ranges up to 200 ma. Most of these tubes are not marketed in this country, although they would appear to be quite useful in many applications where designers are now forced to use series or parallel connection of available tubes.

HOW GOOD IS AN AUDIO TRANSFORMER?

[*from page 21*]

Fig. 7 shows that for a step-down type. As in the previous section, it is assumed that winding resistances are negligible in comparison with the circuit impedances.

A complicating factor is the interwinding capacitance C_R, so it is usual to take steps to eliminate its effect. Some transformers incorporate shields between windings, connected to ground, so that interwinding capacitance is replaced by winding-to-shield, i.e. to ground, capacitance, effectively increasing existing winding capacitance slightly.

Where shields are not employed, it is

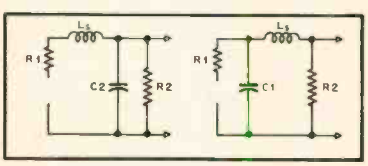


Fig. 8 (left). Elimination of C_R from Fig. 6, and Fig. 9 (right) from Fig. 7.

generally possible to connect the transformer so as to practically eliminate the effect of interwinding capacitance. Interwinding capacitance is the capacitance between the layers of turns that are nearest together in the two windings. These layers will be turns electrically close to one end of their respective windings. By connecting the windings into the external circuit so that the signal potential to ground from one of these ends is zero, the interwinding capacitance will become virtually the capacitance from the other winding to ground. If the ends nearest together in both windings have zero signal potential to ground, the effect of interwinding capacitance is completely eliminated, not even adding to effective winding capacitance, because there is no signal potential across it. (Any d.c. potential between windings will not produce capacitance currents.)

When the effect of interwinding capacitance has been eliminated, the circuits of *Figs.* 6 and 7 become those shown at *Figs.* 8 and 9 respectively. Now, as in the l.f. case, each circuit becomes a simple resonant circuit, in which the impedance connected to the low side of the transformer is series damping, while that connected to the high side is shunt damping. *Figure* 10 shows the h.f. response due to (a) less-than-critical damping, (b) critical damping, (c) more-than-critical damping.

Common cases where inadequate damping gives rise to a h.f. peak are interstage transformers operated in the plate circuit of triodes, and output transformers for tetrode or pentode tubes. Careful attention to the circuit can eliminate an undesirable peak or loss and produce the best possible response.

The internal properties of an audio transformer that set a limit to its frequency range at the upper end are its leakage inductance and the winding capacitance of the high side (including additional capacitance connected across the winding externally, such as grid input and strays). The ultimate cut-off frequency is inversely proportional to the square root of the product of this inductance and capacitance. Both these quantities increase with the size of the transformer so it is clear that smaller transformers have an inherently higher frequency range.

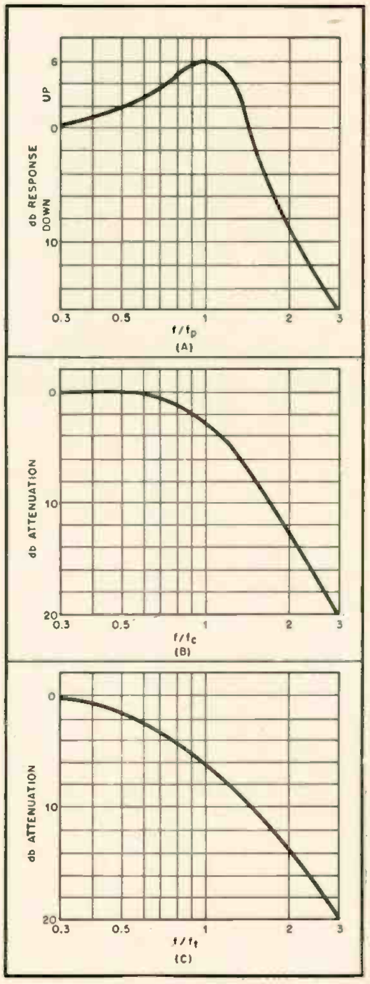


Fig. 10. Attenuation responses for high-frequency cut-off; (A) less-than-critical damping; (B) critical damping; and (C) more-than-critical damping.

Successful operation of any transformer depends appreciably upon the circuit in which it is worked, and the manufacturer's specification does not wholly determine how good any particular transformer is for the job in hand. Simple methods of measuring up the qualities of a transformer and of determining circuit modifications for optimum performance will be discussed in subsequent articles.

BE YOUR OWN CUSTOM-BUILDER

[*from page 26*]

one baffle form, nor does the tuning process apply to but one speaker. You need to know only the resonance of the speaker (check the manufacturer's specifications for this figure), the volume of the cabinet, then apply the following formula:

$$A = \frac{V^2 f^4}{6 \times 10^6}$$

where A = area of the port in square inches

f = frequency at which you desire to tune the enclosure

V = internal volume of enclosure in cubic feet

$6 \times 10^6 = 6{,}000{,}000$

Example: Suppose you are given an 8-cu. ft. enclosure housing an RCA LC-1A speaker. This model has a resonant frequency of approximately 35 cps, so you choose to tune the enclosure at 30 cps, i.e., about 5 cps below the resonant frequency of the speaker, so that in effect the resonance of the enclosure extends the lower range of efficiency of the speaker where it starts to fall off sharply below its resonant frequency. Thus

$f = 30$ cps

$V = 8$ cu. ft.

Therefore,

$$A = \frac{8^2 \times 30^4}{6 \times 10^6} = \frac{64 \times 810{,}000}{6{,}000{,}000} = 8.7 \text{ square inches.}$$

The resulting figure will give you the area of the tuning port for your particular baffle. But, brace the cabinet well. Scraps of wood, glued and screwed, can make your cabinet rigid as a brick wall (and what could be better?). Don't spare the sound-proofing material inside your baffle and you'll come away with a nicely matched unit for far less—considering the performance—than a specially-made speaker baffle.

Finally, we do offer this all-important suggestion: read carefully what the manufacturer has to say about his product. If you question your interpretation of his explanations, then write him, or call him. Critical comment or questioning is welcomed and properly answered. These people are proud of their products, the guaranty enclosed with each piece of audio equipment displays their pride. Should you find trouble, use that warranty. And most important, take advantage of the advice each manufacturer offers you. It means the proper answer to your need: better and more attractive reproduction of recorded and broadcast sound.

BEST BRITISH RECORDS OF 1950-1951

[*from page 28*]

	Casse-Noisette, Suites 1 & 2. O.S.C.C. (Fistoulari).	Lon. LLP441
	Sleeping Princess, Ballet Suite. O.S.C.C. (Desormiere).	Lon. LLP440
Vivaldi	The Four Seasons, Op. 8. Stuttgart Chamber O. (Münchinger).	Lon. LLP386

CONCERTOS

Beethoven	Piano Concerto No. 4. Gieseking & Ph.O. (von Karajan).	Col. LX1443/6
	Violin Concerto in D. Haendel & Ph.O. (Kubelik).	H.M.V. C4126/30
Bruch	Violin Concerto No. 1. Campoli & New S.O. (Kisch).	Lon. LLP395
Ireland	"Mai Dun," symphonic rhapsody. Ireland & Hallé O. (Barbirolli).	H.M.V. DB9651/2
Liszt	Rhapsodie Espagnole. Bachauer & New London S.O.	H.M.V. C7854/5
Mendelssohn	Violin Concerto. Campoli & L.P.O. (van Beinum).	Lon. LPS90
Mozart	Violin Concerto in G, K216. de Vito & R.P.O. (Beecham).	H.M.V. DB2177/9
Tchaikovsky	Piano Concerto No. 1. Solomon & Ph.O. (Dobrowen).	H.M.V. C3996/9

CHAMBER MUSIC

Bliss	String Quartet No. 2 in F. Griller Quartet.	Lon. LPS299
Beethoven	String Quartet No. 15, Op. 132. Griller Quartet.	Lon. LLP318
Bloch	Quintet for piano & strings. Quintetta Chigiano.	Lon. LLP382
Dvorak	Piano Quintet in A, Op. 81. Quintetto Chigiano.	Lon. LLP202
Mozart	Quintet in G minor K516. Gilbert & Griller Quartet.	Lon. LLP132
	Divertimento No. 17 in D, K334. Members of the Vienna Octet.	*Decca LXT2542
	Fünf Kontretänze, K609. London Baroque Ensemble.	Parlo. R20597
Schönberg	Ode to Napoleon Bonaparte, Op. 41. Adler, Monod & Villers Quartet.	Esquire TW4002/3
Sibelius	String Quartet in D minor. Griller Quartet	Lon. LLP304

PIANO

Bach	Chromatic Fantasia & Fugue in D minor. Schnabel.	H.M.V. DB9511/2
	Chorale Preludes: Nun Komm' der Heiden Heiland & Ich Ruf' zu din. Lipatti	Col. LX1427
Chopin	The Waltzes. Lipatti.	Col. LX1341/6
Liszt	Deux Legendes & Années de Pelerinage. Kempff.	Lon. LLP315
Rachmaninov	Suite No. 2 for 2 pianos. Sellick & Smith.	Col. DX1675/7
	The 24 Preludes. Lympany.	Lon. LLP328/9
Schubert	Sonata in B flat (Op. posth.) Kempff.	Lon. LLP307
	Impromptu in C minor Op. 90 No. 1. Schnabel.	H.M.V. DB21320
	Impromptu in E flat Op. 90 No. 2 and Impromptu in G flat Op. 90 No. 3. Schnabel.	H.M.V. DB21335
	Impromptu in A flat Op. 90 No. 4. Schnabel.	H.M.V. DB21351
Schumann	Fantasia in C, Op. 17. Weisz.	Lon. LPS152

VIOLIN

Paganini	Caprices, Op. 1. Ricci.	Lon. LLP259 & 264

PIANO AND VIOLIN

Tartini	Sonata in G minor (Devil's Trill) Campoli & Gritton.	Decca AK2366/7
Walton	Sonata for violin & piano. Menuhin & Kentner.	H.M.V. DB9573/5

PIANO AND 'CELLO

Beethoven	Sonata in C, Op. 102 No. 1. Schnabel & Fournier.	H.M.V. DB9555/6
Fauré	Elegie, Op. 24. Lush and Fournier.	H.M.V. DB21333

ORGAN

Bach	Prelude & Fugue in E minor. Germani.	H.M.V. C3984/5
	Fantasia and Fugue in G minor (The Great) Marcel Dupre.	Decca AK2364/5

(To be concluded)

NEW LITERATURE

• **Audio-Video Recording Co., Inc.,** 730 Fifth Ave., New York 19, N. Y. has recently published a new rate card, describing A-V equipment and listing rates for use of studio facilities, for tape recording, editing, instantaneous disc recording, master disc recording, and processing and pressing. Will be mailed free to any reader making use of recording media.

• **Thordarson Manufacturing Division, Maguire Industries,** Mt. Carmel, Ill. is making available to the electronics industry a finger-tip reference work covering more than 50,000 field-proved transformer designs. Included in the listing are design data covering practically every known type of filter, choke, and transformer presently required by the industry. The material will soon be published in book form and will be available to engineers.

• **Centralab Division of Globe-Union Inc.,** Milwaukee, Wis. has prepared the first color chart ever to include color-coding practices of the entire electronic industry. Included in the chart are codings for transformers, switchboard cable, RTMA and JAN capacitor and resistor values, speakers, and radio and TV chassis. Printed in eleven colors with over 3000 color markings, the chart will be found useful in all phases of electronic design, manufacture, and servicing. Distribution of the 30 x 36-in. chart is through Centralab distributors and jobbers.

• **Cornell-Dubilier Electric Corp.,** South Plainfield, N. J. is now distributing Catalog 200C, a comprehensive listing of service replacement capacitors. Units included in the catalog range from tiny moulded plastic types for use in receivers, to heavy-duty mica capacitors for transmitter application. Contained also are photoflash capacitors. Catalog 200C may be obtained free from Cornell-Dubilier jobbers.

• **M. A. Miller Manufacturing Co.,** 1169 E. 43rd St., Chicago 15, Ill. announces a revised version of the company's cross-reference replacement guide for recording and playback needles. Current as of December, 1951, the guide contains illustrations of various types of needles correlated with corresponding type designations of all manufacturers. Offered as a service to the trade, the guide will be supplied free upon written request.

• **University Loudspeakers, Inc.,** 80 S. Kensico Ave., White Plains, N. Y. will capture the interest of everyone in the audio field with the "Technilog," a 28-page general catalog which provides the answers to many of the problems constantly facing sound technicians and custom installers. In addition to listing the complete line of University speakers, the Technilog contains scores of curves, tables, charts, and circuits, as well as practical discussions on such subjects as overload protection for speakers, impedance matching, baffling, and phasing. Copy obtainable through most radio parts distributors or by writing direct.

• **United Catalog Publishers, Inc.,** 110 Lafayette St., New York 13, N. Y. announces publication of the 16th edition of Radio Master, buying guide for the radio-TV-electronic parts industry. This latest version of what has become virtually an official reference work for the industry contains 1100 pages. More than 75,000 items are cataloged, including 7000 illustrations. Listings represent 90 per cent of all manufacturers of electronic parts and equipment. Copies obtainable from electronic parts jobbers.

• **Hickok Electrical Instrument Co.,** 10617 Dupont Ave., Cleveland 8, Ohio, will mail to interested engineers and technicians a free copy of Bulletin TT5, a 4-page folder illustrating and describing the latest 10-model selection of Hickok mutual-conductance tube testers. Testers described range from the Model 7001, priced in the thousand-dollar bracket, to popular-priced models for radio service application.

• **Astron Corporation,** 255 Grant Ave., East Newark, N. J. lists information of value to all users of capacitors in Catalog AC-3, a comprehensive display of the Company's complete line of dry electrolytics, metallized paper capacitors, and r.f. interference filters. Clear illustrations are enhanced with performance characteristics, schematic drawings, engineering design data, and test procedures. Requests for copy must be on company letterhead.

NEDA and The REPS Dine and Dance Together

SATURDAY EVENING, January 26th, was a gala occasion for the members of the New York Chapters of both the National Electronic Distributors Association and "The Representatives" of Radio Parts Manufacturers. They turned out in full strength for a dinner and dance at New York's Commodore Hotel, and festivities lasted from 7:00 p.m. until exhaustion.

Starting with hors d'oeuvres and cocktails in the South Room, and continuing with a full-course filet mignon dinner in the Century Room, the members, guests, and their ladies celebrated in typical New York fashion.

The affair was staged by the Joint Committee, consisting of NEDA Chairman Milton Fischer with Rubin Green and Fred Rosenstein and the REP Chairman Jules Bressler with Dan Bittan and James Pickett, and the committee reports that "a good time was had by all."

Bressler started the speechmaking with a few introductory words, and welcoming speeches by Charles Ollstein, President of the N. Y. chapter of NEDA, and by James Pickett, president of the N. Y. chapter of the REPS put everyone in a good frame of mind. Honored guests were Joe De Mambro, president of the Boston chapter of NEDA, and Mrs. De Mambro, and the speakers' table was graced with NEDA vice-president Rubin Green, REP vice-president Harry Finkelstein, and secretary-treasurers William Green for NEDA and Wally for the REPS, together with their wives.

Entertainment was provided by a number of well-known artists, including comic Joey Karter of Philadelphia, the Andrews Twins with dance specialties, singers Roy Johnston and his wife, Liza Rutherford, and acrobatic dancer Mary Beth Olds.

THE AUDIO FAIR in CHICAGO

THE PLACE: The Conrad Hilton Hotel, Chicago

THE DATE: May 23rd and May 24th

THE TIME: Opens 10, 00 a.m. Friday, May 23rd
Closes 9: 00 p.m. Saturday, May 24th

Quality Audio comes to Chicago

Will YOU be there?

Radio's MASTER REPORTS

A MONTHLY SUMMARY of product developments and price changes of radio-electronic-television parts and equipment, supplied by United Catalog Publishers, Inc. 110 Lafayette Street, New York City, publishers of Radio's Master.

These REPORTS will keep you up-to-date in this ever-changing industry. They will also help you to buy and specify to best advantage. A complete description of most products will be found in the Official Buying Guide, Radio's Master—available through local radio parts wholesalers.

ANTENNAS AND ACCESSORIES

AMPHENOL. Temporarily discontinued 300-ohm Twin Lead Transmission line #14-358 for FM & TV Antennas, while reinstating Flat Twin Lead #14-056 (500) (1000) at $25.80 net for M ft.

BAKER MFG. CO. Added Antenna Mast No. 10AM, 10′-section of 18-gauge tubing with special Baker joint for stacking at $2.28 net and 20AM, 2-section 20′ telescoping mast for 1-man straight up vertical erection at $9.30 net.

BRACH MFG. CO. Withdrew #407, 1⅛″ Cad. Univ. Base & #439, 4-Bar-1 TV Antenna (stacked) while increasing the prices of two items and decreasing the price on one item in their line of TV Antennas & Systems.

PREMAX PRODUCTS. Revised their entire price line of products which include Antennas & Accessories.

RADELCO MFG. CO. Reduced prices on following categories of their line: FM Dipoles, TV Dipoles, Dipole Accessories and TV Stacking Arrays. Introduced a number of new items on their line which include Mobile & Police Equipment, TV Stacking Arrays, and Dipole Accessories.

TAYLOR MFG. Five new items added to their line of TV Antenna Mast Bases.

BOOKS AND MANUALS

SAMS, HOWARD W. Added RR-2, "The Recording and Reproduction of Sound" at $7.95 net, and Volume 16 Photofact sets in Deluxe Binder, 151 thru 160 at $18.39 net.

VAN NOSTRAND. Increased price of publication "Elementary Radio Servicing" to $4.00 net.

MISCELLANEOUS RADIO, TV AND ELECTRONIC PARTS

AUDIO DEVELOPMENT CO. Reduced prices of Output Transformers 314F to $23.64 net and 314G to $23.58 net.

CENTRALAB. Added two new Controls, B16-128, B16-228 . . . added 13 new Dual Concentric Controls to their SBRT series . . . added D-218, Custom Control . . . added Switches #1470 & 1471 . . . withdrew SBRT-676-S.

CHICAGO TRANSFORMER. Reduced prices approximately 10% on their entire line of Transformers & Reactors.

DAVIES MOLDING CO. Replaced #4100 thru 4103, Electronic Instrument Knobs with #4100-R, 4101-V, 4102-Q and 4103-W; all Pointer Knobs.

ERIE RESISTOR. Increased prices on their entire series of Erie button-style Silver Mica Capacitors, Styles 370CB and 370FA.

MALLORY & CO. Added five new Carbon & Wire Wound Controls and three new "LA" series Jacks.

NATIONAL CO. Decreased prices on capacitors PSE, PSL and PSR 25, 50 and 100 and also Bushings XS-3, 4, 5F, and 7, while increasing price of Insulators AA-3, GS-1 and 4A.

NUCLEAR INSTR. & CHEM. CORP. Introduced Model 1613A "Classmaster" at $139.50 net and MR1 Meter at $31.50 to their line of Geiger Counters.

PHILMORE MFG. CO. Decreased price of DPK, Voltage Doubler Unit to $26.75 net and H109E, 6-ft. Power Supply cord to $.48 net.

PLANET MFG. Added seven new items to their line of Dry Electrolytic Capacitors.

RAYTHEON. Increased price of Rectifilter RFR-1044 GR to $130.00 User price and Withdrew RFR-1044 G.

STANDARD TRANSFORMER. Redesignated Line Adjusters P-6441 thru P-6444 to PV 6441 thru PV 6444 at same prices.

TRIAD TRANSFORMER. Prices on D-1 and D-2, Horizontal Output (Flyback) Transformers reverted back to old prices of $6.27 net each.

TV DEVELOPMENT. Added #CZ-12, Electric Cord Shortener at $1.80 net . . . TN-100, TV Knobs sets at $1.68 net . . . added a new series of 6 set screw type radio knobs available in quantities of 50.

RECORDING EQUIPMENT, SPEAKERS, AMPLIFIERS, NEEDLES, TAPE, ETC. . . .

AMERICAN MICROPHONE. Added four new items to their line of Mikes & Phono Pickups.

CLEVELAND ELECTRONICS. Added Model 18, Automobile Rear Seat Speaker at $5.37 net.

KENT PRODUCTS. CB-100 and CB-106, metal changer bases for the Webster record changer added at $4.08 net.

LEAK AMPLIFIER. (British Industries). Added Model TL/25A, 25 watt Amplifier with RC/PA/U Remote Control Preamplifier, complete at $249.00, and added TL/25A, 25 watt Amplifier only, at $210.70 net.

MASCO. MHP-110 and MA-10-HF, High-Fidelity Amplifiers reduced to $35.93 and $51.24 net respectively . . . MHP-110X and MA-10EX, High-Fidelity Amplifier with expander circuit reduced to $46.55 and $61.26 net respectively.

MILLER, M.A. Added Diamond Stylii for the following: 5 for G.E. Cartridges . . . 5 for Astatic . . . 4 for Electro-Voice . . . 2 for Philco . . . 1 for Philco-Columbia . . . 2 for R.C.A. . . . 3 for Shure Bros. . . . 2 for Magnavox.

SCOTT, HERMON HOSMER. Added new relay-rack Type No. 221-A Laboratory Amplifier, rated power output 20 watts, at $148.50 net and 221-A1 Amplifier at $165.00 net, available on special order. (Output impedances of 4, 8, 16, and 500 ohms.)

UNIVERSITY LOUDSPEAKERS. Diffusicone 8 added at $21.00. . . MM2TC-T and MSR-T, Railroad and Marine type speakers with transformers and volume control added at $17.10 net each . . . reinstated transformer model 5420 at $3.00 net while withdrawing RBP-8 and RBP-12, Radial Cone-Speaker Projectors.

UTAH RADIO. Withdrew 30 items and added 4 items to their line of Speakers . . . also added series of 8 transformers.

TEST EQUIPMENT

SIMPSON ELECTRIC. Decreased prices of a.c. voltmeters Models 155, 156, and 157 to $7.50 net for ranges 0-1.5 to and including 0.100 . . . decreased prices of a.c. voltmeters Models 55, 56, and 57 to $8.10 net for identical ranges . . . prices on d.c. voltmeters Models 125, 126, and 127 decreased to $7.65 net for ranges .0-3 to and including ranges 0-25.

TOOLS AND HARDWARE

UNGAR ELECTRIC TOOLS. No. 535, Heating Unit introduced at $1.10 list. Due to the lack of Tellurium the following items replaced with ⅛" ELKALOY-A tips . . . #331 (straight pencil tip to replace #537SO, #332 curved tip to replace #537), and #333 (chisel tip to replace #538) at $.15 list.

WELLER ELECTRIC. Decreased prices on eight items on their line of Soldering Equipment . . . added #7318, D-207 Trans. Assembly complete at $10.50 net . . . #7334, S-107, Trans. Assembly complete at $9.00 net.

TUBES—RECEIVING, TELEVISION, SPECIAL PURPOSE, ETC. . .

G.E. Increased prices on 112 Industrial & Transmitting Tubes and 66 Receiving Tubes. These new prices are not in excess of ceiling prices which have been filed by G. E. with the O.P.S. . . . added Industrial & Transmitting Tubes 61J (thyratron) . . . GL-5844 . . . TV Tube 17CP4 . . . increased prices on TV Tube 20HP4-A/20LP4 . . . reduced prices on Receiving Tubes 1B3GT, 6AG5 6AU6, 12AU6 and 25W4GT.

NATIONAL UNION. Increased price of Videotron 21FP4A to $45.00 net and decreased 10BP4 and 10BP4A to $23.00 net and 16AP4 to $38.00 net.

RAYTHEON. Added two Picture Tubes, 17AP4 and 20CP4A . . . decreased prices of 15 Picture Tubes in 14", 16", 17", 19", and 20" size . . . increased price of 17HP4 to $27.20 Suggested Dealer Price.

THOMAS ELECTRONICS. Decreased prices on 11 Cathode Ray Tubes in 10", 16", 17", 19", 20" and 21" sizes . . . increased prices on three 16" tubes . . . withdrew two 19" tubes . . . added six in 16", 17", 20", and 21" sizes.

AUDIO PATENTS

[*from page 6*]

the product of resistance and transconductance is the same in both cases. With the 6BN6 the accelerator resistor would be somewhat higher than the plate resistor. To get maximum amplification, the third grid, instead of being tied to cathode, may be biased 2 to 5 volts positive.

Though the writer has not tested the circuit, it would seem to have excellent inherent balance throughout the frequency range. The impedances of both outputs are of the same order, there is no Miller effect, and one output phase has not been obtained by putting signal through two stages as against one stage for the other, as in most inverters.

Copies of any patent may be obtained for 25¢ each from the Commissioner of Patents, Washington 25, D. C.

CLASSIFIED

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

SENSATIONAL REALISM that is hardly believable from hi-fi radio phonograph. Call GLenville 2-8615.

THE AUDIO EXCHANGE buys and sells quality high-fidelity sound systems and components. Guaranteed used and new equipment. Catalogue. Department AE. 159-19 Hillside Avenue, Jamaica 32, New York. OL 8-0445.

PARTNER wanted for established High-Fidelity business in Washington, D.C. Write Box CM-1, Audio Engineering.

CUSTOM QUALITY Williamson amplifiers at bargain prices. New Peerless S-265-Q output, $23. McProud horn with GE S-1201D, $49. Dr. Nicely, Kenton, Ohio.

WANTED: Worn sapphire needles—GE, Audak, Astatic, etc. for microphotographing. Box CM-2, Audio Engineering.

FOR SALE: In cases—one Magnecorder PT6-J & PT6-AH, $375; one Magnecorder PT6-J & PT6-AH, $475; Presto PT900R1 Portable Tape, 3 50-ohm inputs, $650; Altec 323B Amplifier, $65; make offer on Presto L2 playback amplifier-speaker unit; Presto 1C recording head $25; Presto 6N recording case, $20; Shipping charges COD. MASTER-TONE RECORDING CO., Box 1060, Des Moines 11, Iowa.

FOR SALE: Leeds and Northrup decade resistance box, 0–999.9 ohms in steps of 0.1 ohm. $39. Heathkit VTVM, built, $17. Heathkit capacitor checker, built, $12. Jac Holzman, 189 W. 10th St., New York City. OR 5-7137.

1941 REK-O-KUT table and overhead lathe. Brush cutter. Best offer over $60 cash or equipment. Details on request. Gordon, OMR Box 138, Keesler AFB, Miss.

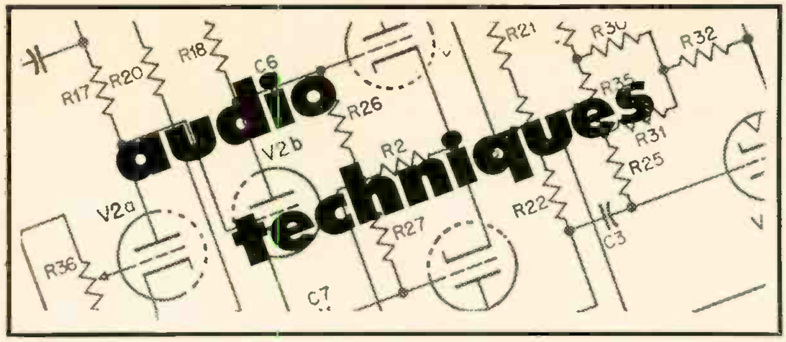
WANTED: Jensen 18-inch Auditorium speaker, model M18-DC. C. Ronsell, 79 Dover St., Dayton 10, Ohio.

PRESTO 900R1 tape recording mechanism, $325. RCA 15-watt PA amplifier, $60. Transcription arm with new GE cartridge, $25. Pilotuner and AM Presto tuner, $90. RECO-ART, 1305 Market St., Philadelphia, Pa.

WOULD LIKE to purchase used Ampex or Magnecorder. State model, condition, price. Jac Holzman, 189 W. 10th St., New York City.

FOR SALE: 2 totally enclosed cabinets, #1—31" high, 22" wide, 17" deep, 5 cu.ft. #2—24"×19"×15", 3 cu.ft., both painted light gray, and lined with 1" felt. Sloping front, suitable for WE 728B, 754A, 755A, 756A; make offer. T. M. Olsen, 745 E. 242 St., Bronx 70, N. Y. FA 4-4866.

PROFESSIONAL DIRECTORY



Improved Cathode Bias Circuit Affording Fixed Bias

JOHN A. MULVEY

OFTEN IN THE INTERESTS of economy, simplicity, or dependability—or all three—the designer of an audio output stage will decide to sacrifice the claimed advantages of fixed bias and use cathode bias. The conventional fixed-bias arrangement usually requires a separate transformer, or a bias-tapped power transformer, and a separate rectifier with its associated filtering network, besides the need for fusing the plate circuit of the output tube to protect it in the event of bias failure. Most fixed bias circuits take time to develop a bias voltage after a set is turned on, and thereby are apt to allow a certain period of improper operation to the output tubes. Though this interval of time may be small, it becomes significant when it recurs repeatedly as the set is turned on and off, as any amplifier usually is. With some tubes—the 6AS7G, for instance—the manufacturers specifically do *not* recommend fixed bias operation, since even a short period of high current drain from the cathodes before they are fully heated will seriously harm the tube. These considerations sway most designers to ignore fixed bias.

The accompanying diagram shows a simple inexpensive method used by the author for achieving fixed bias with what is basically a cathode bias circuit. The idea is to return the grid circuits of the output tubes through a network built around the usual cathode bias resistor. This can be made to provide a fixed bias voltage between grid return and cathode. By choosing a suitable resistance value for the cathode resistor such that the voltage developed across it due to the total cathode current will be considerably more than required for bias voltage, a circuit such as that shown can be wired in parallel to it that will give almost perfect regulation to a voltage developed between some midpoint in the branch and the cathode. A filter capacitor could be substituted for the OC3/VR105 shown. However, this would delay somewhat the bias voltage developed for the grid. For such a substitution, a 6800-ohm resistor should be used instead of the 2700-ohm resistor shown. The use of a capacitor in this manner does provide one advantage in addition to a small saving in time of assembly and in expense, and it does provide a favorable automatic bias change with changing line voltage. The potentiometer shown is for balancing plate currents in the two tubes or in the two sections of such a tube as the 6AS7G.

Modifications suggest themselves for other tubes which require less bias voltage. The OA3/VR75 will provide an economy of required plate voltage.

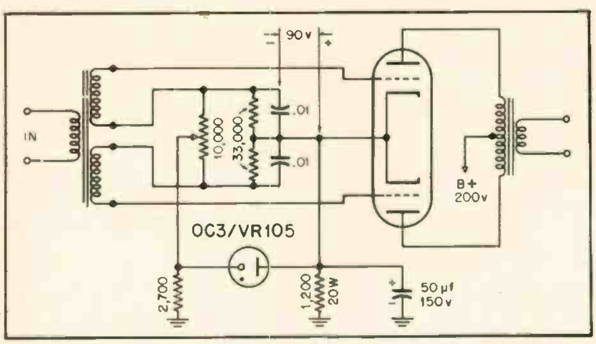


Fig. 1. Output stage arrangement to provide fixed bias from a cathode-bias circuit.

3080 S. W. Spring Garden Road, Portland, Ore.

AUDIO engineering society

APPLICATION FOR MEMBERSHIP

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

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

....
Print or Type Name in Full

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

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

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

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

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

....

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

....

....

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

....

EDUCATION

SCHOOL ATTENDED	FROM	TO	COURSE	DEGREE

ADMISSION REQUIREMENTS

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

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

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

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

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

REFERENCES

Name *Company and Address* *Title or Position*

1. ....
2. ....
3. ....

....
Signature of Applicant

PLEASE DO NOT WRITE IN THIS SPACE

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

Industry People...

Rumor floating eastward from the Windy City hints that **Sam Poncher**, president, Newark Electric Co., Inc., Chicago, is planning to open one of the country's plushiest Sound Departments. . . . More than Windy City rumor is the announcement of **Harry N. Reizes**, manager of The Audio Fair, that there will be a Fair in Chicago come May—will be held in the Conrad Hilton hotel immediately following the Electronic Parts Show. . . . **Irving Greene**, Sound Department director of Manhattan's Sun Radio & Electronics Co. and co-author of the book "Make Music Live," is answering once more to "Sergeant"—thanks to **John Conly** article in current Atlantic Monthly. . . . "Saturday Review of Recorded Music" is title of new book due off Prentice-Hall presses within a few weeks—written by **Edward Tatnall Canby, C. G. Burke,** and **Irving Kolodin**, all contributors to the Saturday Review of Literature. . . .

Charles Shaw has been appointed head of the newly expanded purchasing department of Triad Transformer Manufacturing Co., Los Angeles. . . . **Charles P. Cushway**, formerly executive veepee of Webster-Chicago Corp. has joined Crescent Industries, Inc., Chicago, in similar capacity. . . . **Paul Gaynor** is new veepee in charge of merchandising for CBS-Columbia, Inc., New York, according to announcement of **David Cogan**, firm president. . . . **Leslie F. Muter**, head of the firm bearing his name, was re-elected president of the Radar-Radio Industries of Chicago, Inc., at annual meeting—other officers are **Paul V. Galvin** of Motorola, **Raymond F. Durst** of Hallicrafters, and **Richard Graver** of Admiral, vice-presidents; **James P. Wray** of Croname and **Charles M. Hofman** of Belmont, directors, and **Robert S. Alexander**, treasurer. . . . New personnel manager of Canadian Aviation Electronics, Ltd., is **Francis J. MacNamara**. . . .

Karl Kramer technical service manager for Jensen Manufacturing Co., Chicago, scored customary hit in recent appearance before Indianapolis Section of I.R.E.—delivered paper on high fidelity in conjunction with demonstration of Jensen's G-610 Triaxial speaker. . . . **Eugene Roeske, George Adams** and **Howard Roth**, all industry pioneers, are announced by **L. M. Heineman**, president, as newest additions to top echelon of Permoflux Corp., Chicago. . . . **James Harger**, prominent Ridgewood, N. J. audio hobbyist, is new assistant to the president of Huffman & Boyle Furniture Co. . . .

Harvey E. Sampson, president, Harvey Radio Co., New York, is latest of country's leading electronic jobbers to announce a catalog devoted solely to audio—scheduled to leave the presses sometime in March. . . . **Hallicrafters, Inc.**, Chicago, reportedly on verge of marketing high-quality radio-phonograph in near future. . . . Other manufacturers rumored about to expand interests in audio field are **Stromberg Carlson** and **General Electric**. . . . **Everett E. Gramer**, veepee of Gramer Transformer Corp., Chicago, has assumed duties as Western sales manager for the firm. . . . Minnesota Mining and Manufacturing Co., St. Paul, Minn., has promoted six key executives to new posts—names and new capacities are: **Louis F. Weyand**, executive v.p., **Robert W. Young**, board chairman of 3M International, **Clarence B. Sampair**, president of 3M International, **John A. Borden**, sales and marketing consultant for all 3M tapes, **George W. Swensen** and **Hubert J. Tierney**, veepees of the parent company. . . . **Gordon C. LeRoy** has been appointed New York state sales rep by David Bogen Co., New York City.

LETTERS

[*from page 10*]

I do not think you should diffuse your emphasis into the problems of all types of intelligence carriers—leave that to others. And, if readers could stand Latin and Greek roots in one name, I suggest *Datumism Engineering* as a possible name.

J. N. A. Hawkins,
The Rollin Company,
2070 N. Fair Oaks,
Pasadena 3, California

(*We think we've got about all we can handle with Audio alone.*—ED.)

SPEAKEASIES

Although there is no "boom" in the reproduction given by the Hartley-Turner 215 speaker (because they have no bass resonance), there has recently been quite a boom in Hartley-Turner speakeasies. If you wonder what the heck these are, then you are not a subscriber to our technical data and news service.

But you who are know all about them, and our honest advice to you is that you start forming one just as soon as possible, for the simple reason that our ramifications throughout the U.S.A. are—well, just ramifying more than ever, and the time may come when you will not be able to do so because we have so many agents.

It is significant that this spurt in co-operative trading has come just after our visit to the Audio Fair, for the aftermath of that, apart from the obvious one of there being many more admirers of the 215 than ever before, is that it will not be very long before we enter the second phase of our "American campaign."

First we had to introduce you to a new and entirely exciting speaker which sounded like no other simply because it sounded REAL. After three years we can say with pride that the 215 is now very well spoken of in all quarters, and we are told that the company behind the speaker is not so bad either. Now we enter the period of solid establishment, for our speakers have come to stay with you for all time, gaining new friends. How that will be done will be told to you as our plans develop.

We are hopeful that by the time this ad appears, all our subscribers will have been given a foretaste of what is to come. If you are not a subscriber, the cost is just one dollar bill. There is nothing further to pay, and you will also be introduced to the speakeasy.

The price of the 215 speaker is $48.00 (all charges except import duty paid), but if you are a member of a speakeasy it will cost you less. And at that price we are quite prepared to put it up against any other speaker at any price.

But if you don't feel like parting with a dollar, we shall be glad to send you a very comprehensive technical report on the speaker which will confirm what we have just said. Just a postcard saying "report please." We will do the rest.

H. A. HARTLEY CO. LTD.
152, Hammersmith Road
London W.6, England

ADVERTISING INDEX

PARTRIDGE WILLIAMSON
OUTPUT TRANSFORMER
Built to the original specification

De-luxe model now available from stock from all important Radio Stores throughout the U.S.A. (Price $26.00 duty paid)

This transformer is now accepted as the most efficient in the world. According to "Audio Engineering" (Nov. 1949), there is no U.S. equivalent. Thousands already sold in the U.S.A.

Partridge CFB Output Transformer, accepted as without rival. Series leakage induct .10 mh., primary shunt induct, 130 H., with "C" core construction and hermetically sealed. (Price $40.00 duty paid)

The Following Stores are among those now Stocking Partridge Transformers.

Harvey Radio Co. Inc. 103 West 43rd Street, New York 18.

Electronic Wholesalers Inc. 2345 Sherman Ave., Washington, D. C.

Radio Electric Service Co. 5 North Howard Street, Baltimore 1, Maryland.

Gates Radio Company, Quincy, Illinois.

Terminal Radio Corporation. 85, Cortlandt Street, New York 7.

Gates Radio Company, 2700 Polk Avenue, Houston Texas.

Wholesale Radio Parts Co. Inc. 311 W. Baltimore St., Baltimore 1, Maryland.

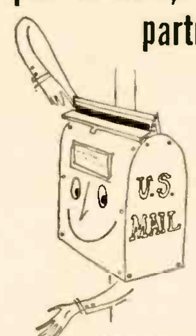
Sole Agents in Canada: Atlas Radio Corporation, 560 King Street West, Toronto 2-B.

If you are unable to purchase Partridge transformers in your city, write to us and mention the name of your dealer.

Fullest data, including square-wave tests, distortion curves, etc., together with list of U. S. stockists rushed Air Mail to you.

PARTRIDGE TRANSFORMERS LTD.
TOLWORTH, SURREY, ENGLAND

put 'er here, partner!



500,000 Mail boxes in the United States are your partners in the fight against cancer.

A contribution addressed to "Cancer" in care of your local post office will help guard your family, yourself and your community.

Next time you see a mail box, "put 'er there, partner!" . . . as generously as you can.

AMERICAN CANCER SOCIETY

Here is my contribution of $ ....
in support of the Cancer Crusade.

Name ____________________

Address ____________________

City ____________ *State* ____________

METERS ARE ACCURATE...

TALK IS NOT...!

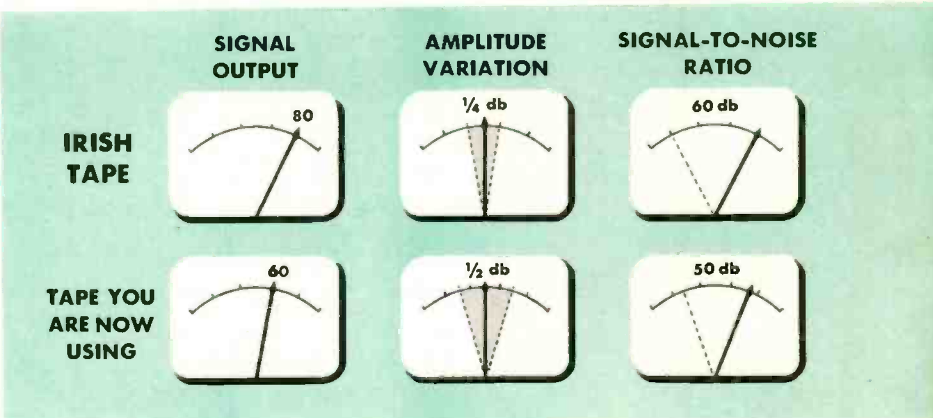
When an important conclusion is to be reached... when a dependable comparison is to be made... among several supposedly similar products... we do not rely upon conversation, claims and mere words! WE WANT FACTS...!

So, when it comes to comparing Magnetic Sound Recording Tape ... words don't mean a thing, unless supported by laboratory experience. And, in view of the ease with which accurate measurements can be obtained, it seems entirely unnecessary and even hazardous to make a choice based upon the uncertainty of the spoken word or written claim.

MAKE THIS ABSOLUTELY FOOL-PROOF TEST BY ACTUAL METER READINGS:

1. Splice end-to-end, **ORRADIO IRISH BRAND** 211 RPA with any conventionol tape you may be now using.
2. Record a 6000 cps audio signal *through the splice* from **ORRADIO 211RPA** to the "comparison" tape.
3. Rewind and play back with your VU meter across the output.

THE DIFFERENCE WILL BE STARTLING!



NOTE: **The greater Volume Output of ORRADIO IRISH TAPE.**

NOTE: **The greater Amplitude Constancy of ORRADIO IRISH TAPE.**

NOTE: **The greater Signal-to-Noise Ratio of ORRADIO IRISH TAPE.**

The performance results will be comparable at other frequencies, as well. This is metered proof of the superior quality of **ORRADIO IRISH** Magnetic Tapes.

The Reason?

There are differences in Magnetic Oxides. ***ORRADIO*** *molecular lubricated oxides are more stable to coating conditions and turn out more uniform dispersions... that is one of the reasons for the growing acceptance of* ***ORRADIO*** *Tape.*

Be sure your next Tape has molecular lubricated oxide. You can be sure of the finest recordings possible with ***ORRADIO 211RPA*** *Plastic Base Professional Tape. Available at your local Radio Parts Distributor or at your favorite Photo Supply Store.*

SOUND RECORDING
REG. U.S. PAT. OFF.

Manufactured in U.S.A. by

ORRADIO INDUSTRIES, INC. OPELIKA, ALABAMA

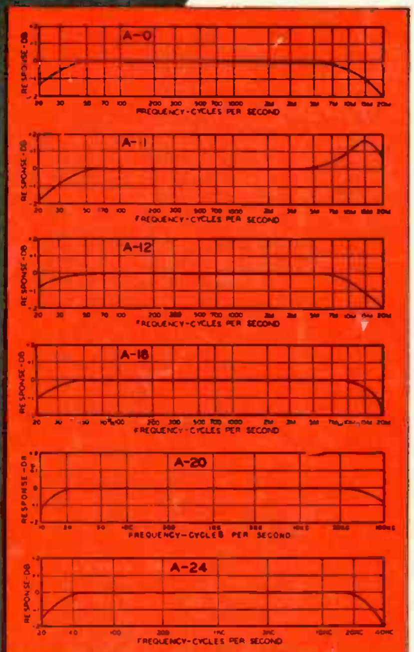
World's Largest Exclusive Magnetic Tape Manufacturer

ULTRA COMPACT UNITS...OUNCER UNITS

HIGH FIDELITY . . . . SMALL SIZE . . . . FROM STOCK

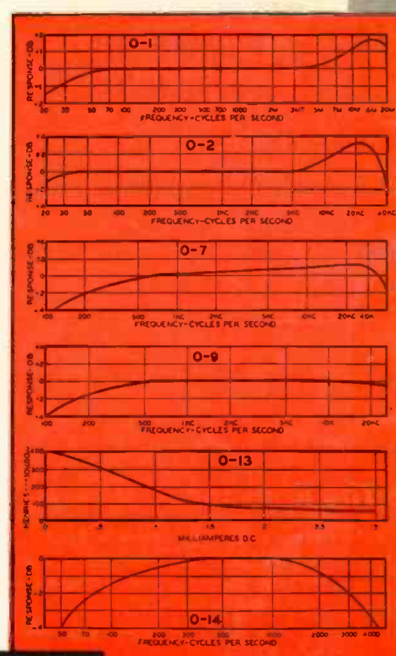
UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.



Type No.	Application	Primary Impedance	Secondary Impedance	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50 ohms	$16.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids (multiple alloy shields for low hum pickup)	50, 200, 500	50,000 ohms	18.00
A-12	Low impedance mike, pickup, or multiple line to grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall, in two sections	16.00
A-14	Dynamic microphone to one or two grids	30 ohms	50,000 ohms overall, in two sections	17.00
A-20	Mixing, mike, pickup, or multiple line to line	50, 125/150, 200/250, 333, 500/600 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-21	mixing, low impedance mike, pickup, or line to line (multiple alloy shields for low hum pickup)	50, 200/250, 500/600	50, 200/250, 500/600	18.00
A-16	Single plate to single grid	15,000 ohms	60,000 ohms, 2:1 ratio	15.00
A-17	Single plate to single grid 8 MA unbalanced D.C.	As above	As above	17.00
A-18	Single plate to two grids. Split primary	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	18.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	19.00
A-24	Single plate to multiple line	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	17.00
A-26	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-27	Crystal microphone to multiple line	100,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	16.00
A-30	Audio choke, 250 henrys @ 5 MA 6000 ohms D.C., 65 henrys @ 10 MA 1500 ohms D.C.			12.00
A-32	Filter choke 60 henrys @ 15 MA 2000 ohms D.C., 15 henrys @ 30 MA 500 ohms D.C.			10.00

TYPE A CASE
1½" x 1½" x 2" high



UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ⅞" diameter... mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4,000 cycles. Maximum level 0 DB.

OUNCER CASE
⅞" Dia. x 1⅛" high

Type No.	Application	Pri. Imp.	Sec. Imp.	List Price
0-1	Mike, pickup or line to 1 grid	50, 200/250 500/600	50,000	$14.00
0-2	Mike, pickup or line to 2 grids	50, 200/250 500/600	50,000	14.00
0-3	Dynamic mike to 1 grid	7.5/30	50,000	13.00
0-4	Single plate to 1 grid	15,000	60,000	11.00
0-5	Plate to grid, D.C. in Pri.	15,000	60,000	11.00
0-6	Single plate to 2 grids	15,000	95,000	13.00
0-7	Plate to 2 grids, D.C. in Pri.	15,000	35,000	13.00
0-8	Single plate to line	15,000	50, 200/250, 500/600	14.00
0-9	Plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600	14.00
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600	14.00
0-11	Crystal mike to line	50,000	50, 200/250, 500/600	14.00
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600	13.00
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C.,		6000 ohms	10.00
0-14	50:1 mike or line to grid	200	½ megohm	14.00
0-15	10:1 single plate to grid	15,000	1 megohm	14.00

United Transformer Co.

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