THE PIANO by Albert Preisman - See page 26

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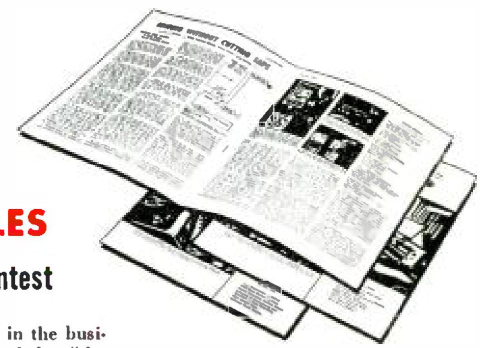


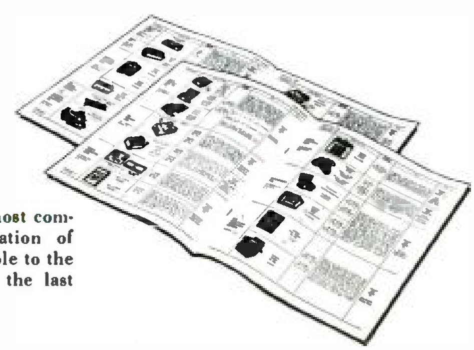
20 PRIZE-WINNING ARTICLES

from Audio's International Sound Recording Contest

Here's a wealth of new ideas on how to use tape and disc recordings to achieve greater economy and efficiency in radio, TV and sound studio operation.

With reference to these articles, one of the contest judges commented as follows: "I have never received so much information which was new and exciting in such a short time in all of my years in the business." And another judge stated that "the information and descriptions of recording operations conducted in small radio stations and recording studios throughout the country has been quite an education."

Contest winners include entries from 11 different States, as well as from Canada and Switzerland. The 20 best articles, which were awarded cash prizes totaling $1400, will be published in the pages of Audio Record. The information thus made available to the industry will be of real value to sound recordists everywhere.



QUICK FACTS ON MAGNETIC TAPE RECORDERS

Each year, Audio Record brings you a complete, up-to-date listing of all makes and models of tape recording machines—with conveniently arranged price and performance data. This directory issue, published in September, is the most complete and authoritative compilation of tape recorder information available to the industry. Over 75,000 copies of the last issue were distributed.

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Audio Record keeps you well informed on all the latest trends and technical developments in all phases of tape and disc recording. It is not an advertising publication and its sole purpose is to render a needed and useful service to the industry.

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COVER

Names Make News! And the important names during October are those associated with Audio, because the year's outstanding audio event takes place then at Hotel New Yorker. With exhibits overflowing three floors, the Fifth Audio Fair is certain to be the most-attended audio exhibit ever.

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

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Avenue, Lancaster, Pa. by Radio Magazines, Inc., Henry A. Schober, President; C. G. McProud, Secretary. Executive and Editorial Offices: 204 Front St., Mineola, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years; elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A. Entered as Second Class Matter February 9, 1950, at the Post Office, Lancaster, Pa. under the Act of March 3, 1879.

AUDIO PATENTS

RICHARD H. DORF*

THERE ARE many reasons why disc records are still by all odds the most important form of commercial recording, even though a few companies have undertaken to build tape libraries and probably more will do so and on a wider scale in the future. Discs are cheaper and easier to use, and they lend themselves to mass production methods.

Tapes, on the other hand, have the potential or less wear after a given number of playings and longer uninterrupted playing time. However, at least so far, they must be reproduced for mass sale by the relatively crude process of rerecording. Each copy must be made, that is, by running it through a recording machine which is fed signals from a master tape.

A few concerns have outfitted themselves with multiple recording setups for this purpose and, as might be expected, the resulting quality is as good as anyone would want, though the output in number of tapes per day is small. One problem remains, however, in a setup of this kind—inspection of the finished product. With discs an inspector can simply take a look at a record to see that the grooves are there and that there is modulation; and a random sampling can be played from time to time. This is not, of course, a completely adequate procedure, but discs are cheap enough to replace and only a small percentage of them goes to a quality-conscious market. Visual inspection of tapes is, of course, impractical. Aural monitoring of each tape as it goes through the copying procedure is equally impractical, since many are running simultaneously. Yet tapes go to quality-minded audiences and should, if possible, be inspected more stringently than discs.

Gilbert F. Dutton of Iver Heath, England, has patented and assigned to EMI a system of automatic monitoring of tapes as they are produced. His patent is numbered 2,622,155.

Figure 1 shows the standard setup for multiple tape copying. A master and a number of copy tapes (only two of the latter are shown) run simultaneously, the tapes driven in the illustration by a single motor. Playback head A picks up the signal from the master tape. This signal is amplified and fed to recording heads C, of which there is one for each copy tape, all in parallel.

Heads B and D and the additional amplifiers and rectifiers are the substance of the invention. Head B is a second playback head which picks up signal from the master tape; it is mounted a carefully measured distance away from head A and is so placed that a given signal reaches it *after* it has reached the main playback head A. Each copy setup has a playback head D which is carefully positioned the same distance from head C as B is from A. As a result, heads B and D should all pick up the same signals at the same instants. If they are not, there is trouble in the system—a binding drive mechanism, which would cause phase shift, a bad recording amplifier, or bad heads or connections somewhere, which could cause absence of signal, lowered amplitude, or waveform changes.

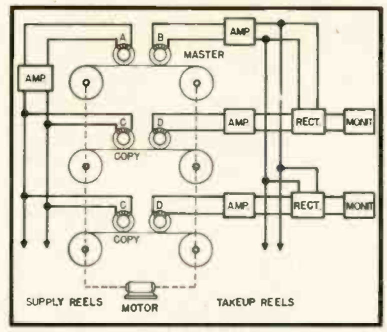

Fig. 1.

The output of head B on the master tape is amplified and fed to a number of rectifiers, one for each copy tape. To each rectifier, in parallel with this signal (though with some isolation) is fed the amplified signal from a head D. The two signals fed to each rectifier should be identical in waveform, and in amplitude (the amplifiers are so adjusted), and exactly opposite in phase (achieved by deliberately reversing polarity somewhere). If so, the net input to the rectifier will be zero signal and no output will appear. If, however, some defect causes the signal recorded on a copy tape to differ in any respect from the master signal, the perfect cancellation will no longer take place. The rectifier will produce a d.c. proportional to the difference between the two monitoring signals and this may be used to operate an alarm of some sort.

The system as described will work to very close tolerances, sometimes too close. For instance, if the two heads A and B and heads C and D are not maintained and aligned at a very precisely equal distance

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

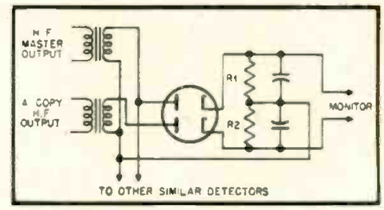

Fig. 2.

apart, there will be a phase difference in the signals. This will be noticeable first in high-frequancy signals because the wavelengths are shorter. Adjustment to achieve actual perfection of distances would be very unnecessarily difficult. The inventor, therefore, modifies the original idea slightly.

He first passes the signals from each playback head B and D through both low- and high-pass filters, obtaining for each tape two signals, one including frequencies below 1,000 cps and one including those above. The low-frequency signals are treated just as in *Fig.* 1, with automatic monitors sensitive to any discrepancies whatever. This will show up variations in tape speed and any wow or flutter of sufficient importance to cause appreciable phase shift below 1,000 cps.

The high-frequency signals are amplified and compared by the circuit shown in *Fig.* 2, a differential rectifier which is sensitive only to net amplitude variations, which would be caused by actual amplitude variations or by waveform differences. It is insensitive to phase shift. One rectifier element is used to produce somewhat filtered d.c. from the master tape output; the other does the same for the copy tape output. The phases of the signals are opposite at the transformers, so that the rectified signal appearing across R_1 is opposite in polarity to that across R_2. The monitoring alarm is connected across the cathodes, so that if both signals are identical in average amplitude the alarm will not be triggered. If these are not the same, a differential voltage is produced and actuates the alarm.

Any Insomniacs Present?

This next item is not presented as an example of advanced design techniques but just in case you can't sleep. It is called by its inventor, Charles Beazley of Chicago, the Slumberbug, and the patent is 2,644,-153.

Its simply circuitry is diagrammed in *Fig.* 3. The 60-cps line voltage is applied to a small loudspeaker through the heater of a thermal relay or slow flasher. When the flasher heats, its normally open contacts close, and the heater is shorted. When the heater cools, the contacts open again and the cycle starts over. The choke and

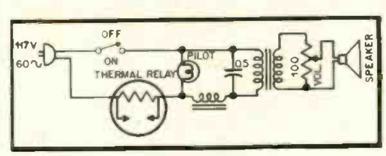

Fig. 3.

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capacitor filter both the relay clicks and the harmonics of the line voltage.

The idea behind all this is that the speaker produces a steady hum. When the relay contacts close (after about four seconds) the hum gets louder since the relay heater, in series with the line, is shorted. Then, four seconds later the volume goes down again. The inventor claims that the steady humming sound, with this slow, rhythmic, change in volume, has a sort of hypnotic effect and will put you to sleep. I wouldn't be at all surprised if it did just that, too.

The price of patent copies remains at 25¢; to look over any one, send your quarter, with the patent number, to The Commissioner of Patents, Washington 25, D. C.

NEW LITERATURE

• **Photocircuits Corporation,** Glen Cove, N. Y., does a fine job of familiarizing manufacturers with the various aspects of printed circuits in a new 8-page 2-color booklet. Exceptionally well-produced, the publication touches on such diverse points as assembly of printed-circuit components into finished electronic devices, suggested applications, and cost estimates. The printed-circuit technique is graphically portrayed. From a competitive standpoint alone, manufacturers of electronic gear should regard this booklet as a necessity.

• **P. R. Mallory & Co., Inc.,** 3029 E. Washington St., Indianapolis 6, Ind., is now distributing to dealers and servicemen the new 1953 Mallory Distributor Catalog No. 553. Listing and describing more than 2200 items, most of which are replacement components handled through the Mallory distributor system, the catalog this year for the first time also includes list prices. Available on request to the company.

• **General Electric Company,** Electronics Park, Syracuse, N. Y., has earned the approbation of record collectors with a new 20-page booklet titled "Variable Reluctance Application Data—a Guide for the Audio Hobbyist." Although its text and illustrations are confined largely to GE products, the booklet contains a wealth of practical information which is exceptionally well presented. Superb pictures and drawings, together with competent writing, give this book a value which is far greater than casual.

• **Newcomb Audio Products Co.,** 6824 Lexington Ave., Hollywood, Calif., is now distributing a new 20-page catalog of public address equipment. Contained is illustrated information on all three lines of Newcomb amplifiers, portable systems and accessories, as well as rack and panel assemblies. Copy will be mailed on request.

• **Vector Electronic Company,** 3352 San Fernando Road, Los Angeles 65, Calif., illustrates and describes a complete line of plug-in circuit units, socket-turrets, and socket-strips in Catalog 53, a 10-page two-color publication which is now available on request. This book will be a boon to all developmental and design engineers.

• **Stackpole Carbon Company,** St. Marys, Pa., in Catalog 40A, describes standard and special carbon and graphite components and materials for chemical, electrical, and mechanical applications. Recently revised and enlarged, the 44-page book contains data on carbon and graphite as applied to products ranging from welding carbons to tude anodes. Copy of Catalog 40A will be mailed on letterhead request.

• **Dow Corning Corporation,** Midland, Mich., has developed a new silicone magnet-wire enamel which has the same life expectancy at 200 deg. C. as conventional enamels have at 105 deg. C. Known as Dow Corning 1360, the new material is not yet available commercially but its various properties are shown on mimeographed data sheets which will be mailed on request. In view of the promise Dow Corning 1360 holds for manufacturers of small motors and miniature electronic equipment, this column suggests that your request be not withheld.

LETTERS

Mu-Beta versus A-Beta

SIR:

I would like to thank Mr. Mitchell for correctly pointing out an error in Chapter 12, Part I of my "Handbook." Negative voltage feedback does reduce the source impedance of an amplifier (considered as the impedance seen by the load) by the factor $1/(1-\mu\beta)$, nor $1/(1-A\beta)$ as written, and the difference between these two expressions, while not significant with triode output stages, is very large with beam-power tetrodes.

Engineers reading Mr. Mitchell's letter will have understood that, with β taken in the normal sense, μ does not refer to the amplification factor of the output tubes, but is the "μ" of the entire feedback loop; that is, the no-load voltage gain between the point of re-entry of the feedback signal and the point from which the feedback voltage is tapped. To some, however, there may seem to be a confusion of symbols. It is for this reason that I have used, in a later installment wherein is described the effect of feedback on source impedance, the symbol A' (loop gain with the load open) instead of μ.

While I am on the subject of errors, and before someone takes me to task, may I take the occasion to make another correction; the term "magnetomotive force" has been applied incorrectly in the section on loudspeakers, although I think the sense will be clear.

EDGAR M. VILLCHUR,
Woodstock, New York.

SIR:

After reading Mr. Mitchell's comments on output impedance reduction in LETTERS for August, I would like to submit the following comments:

Regarding the factor by which the effective output impedance of an amplifier is reduced by the use of negative voltage feedback, it should be pointed out for the sake of accuracy that neither Mr. Villchur's factor of $1/(1-A\beta)$ nor Mr. Mitchell's figure of $1/(1-\mu\beta)$ is completely accurate. The correct factor for the reduction of output impedance is $1/(1-\mu A_1\beta)$, where A_1 is the amplification *from the point* at which the feedback is introduced *up to the grid* of the output stage.

Thus Mr. Mitchell's factor is correct only when A_1 is unity, or when negative feedback is taken over the output stage *alone*. Feedback over only the output stage is not employed very often now for reasons which were correctly cited by Mr. Villchur. A re-check of this section (Æ, July 1953) discloses that in the illustrative *Fig.* 12—9 shown, the value of A_1 would be the product of the amplifications of the first stage (cathode to plate), and the phase splitter. In any case, μ is the amplification factor of the output stage.

Thus it should be recognized that the correct factor—regardless of the point at which feedback is introduced—is $1/(1-\mu A_1\beta)$, and that Mr. Mitchell's factor is correct only when the feedback encompasses the output stage alone.

WILLIAM J. KESSLER,
College of Engineering,
University of Florida,
Gainesville, Florida.

Balancing Tubes

SIR:

In reference to the letter on tube balancing, and also regarding the many circuits published in Æ and in other publications, may I point out an extremely simple means of accomplishing this.

Disconnect the lead from the plate terminal of one of the output tubes, and connect the plate terminal to the plate terminal of the other output tube. Thus you have a single-ended output stage with the grids fed in push-pull. Then feed a signal through the amplifier while an indicating device (a headset is excellent) is connected to the output. The balance control is then adjusted for no sound in the phones or for a minimum in the output indicator. Restore the connections to their original condition and the operation is completed.

JOHN CARLSON,
160 Beacon St.,
Milton, Mass.

(Note: *This method would most certainly work to provide a dynamic balance of the output stage—that is, to an audio or a.c. signal—but would not give a balance between the d.c. flowing in the two tubes. Two problems are encountered—in most instances the dynamic or a.c. balance would be preferable, and usually provides the lower intermodulation distortion. However, an excessive d.c. unbalance right reduce low-frequency response by reason of the magnetization of the output transformer core which would result in lowered inductance. Unless the tubes*

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differed greatly in plate current, the method suggested by Mr. Carlson seems to be preferred. In amplifiers in which the output cathodes are connected together, and thence through a resistance network (or even a single resistor) to ground, we suggest the permanent installation of a 15-ohm, 1-watt resistor from each cathode to the junction of the two leads. These resistors should be matched to around 1 per cent. Then a d.c. balance could be indicated by connecting a sensitive meter between the two cathodes and adjusting for a zero deflection of the meter. We also prefer an a.c. balance at some stage ahead of the output stage—possibly in the plate circuit of the driver stage, as originally suggested by Williamson in his first article on the now-famous amplifier. ED.)

Figure of Merit Again

SIR:

I consider that Becker's approach to the Power Tube Figure of Merit is from the wrong angle. The real criterion is the end effect, in which the power tubes are one item only, although admittedly an important one.

The end effect is conditioned by two main parameters: fidelity, which includes distortion and noise, and cost, which sets a ceiling on capital outlay and running cost, and thus automatically puts a premium on those power tubes which achieve the desired end effect for the lowest total dissipation.

The most important factor is "true E_g", which is "published E_g" multiplied by the feedback factor β, since low distortion can be achieved only by the use of inverse feedback. For example, a pair of tubes requiring only 20 volts to drive them to 10 watts, but producing 10 per cent distortion at that level, will require a feedback factor of 10 to reduce distortion to a design figure of 1 per cent, so that "true E_g" becomes 200 volts grid drive. Another pair requiring 40 volts drive at 4 per cent distortion will achieve 1 per cent with a feedback of 4, requiring a grid drive on only 160 volts.

In the following formula d is the published distortion figure, d' is the design distortion level, E_g the published grid drive at maximum output, and D the sum of plate, screen, and heater dissipations. I see no advantage in penalising R_L, save that abnormally high figures make transformer design somewhat more critical. P is designed power output, and is probably the same as published maximum output. The constant 10^3 is solely for convenience, and renders an answer a little greater than unity.

$$F \text{ of } M = \frac{P \times 10^3}{\frac{d}{d'} \times E_g \times \sqrt{D}}$$

By this formula, the older pairs such as KT66 and 6L6 are roughly equivalent, the former scoring on lower "true E_g" and the latter on lower dissipation. 6V6's show up well on low dissipation. Top scorers so far checked are RCA 6146, with its European equivalent the Philips/Mullard EL31, and British Mazda 11/E1, with efficiencies nearly twice as great. These conclusions agree with known data and experience.

The numerical value of the answers will, of course, depend on d', but the ratios between answers, and consequently the information value to an engineer, will remain constant.

R. B. DYER,
33 Lower Bostion Road,
London, W. 7.,
England.

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R-C Coupled Amplifier Charts

In amplifiers up to about 75 watts power output, it is customary to eliminate all iron-core components with the exception of the rather unavoidable output transformer. The amplification from input to power amplifier grid is obtained with resistance coupling, for which one may be guided by data published in tube handbooks.

R-C coupled amplifier charts present values of cathode and screen resistance for use with various values of plate voltage, plate-load resistance, and grid-circuit resistance in the following stage. Values of cathode and screen resistance are based upon maximum useful output voltage. The data includes this output voltage, and the amplification under stated conditions.

Circuit constants and operating capabilities presented in these charts are averages based upon experiment. Accuracy implied by some of the numbers is greater than that warranted by consistency of the tubes; however, rounding off the values would tend to obscure trends in the data, and would make interpolation more difficult should the circuit designer use conditions not specifically listed in the charts.

With triodes, the cathode-bias resistance is chosen so that the stage will accommodate the largest output signal for 5 per cent harmonic distortion and no more than 0.1 microampere grid current. Cathode by-pass and coupling capacitances listed in the data each cause 10 per cent lower amplification at 100 cps than at mid-frequencies. Thus the relative gain at 100 cps will be down roughly 2 db per stage. The suggested capacitances, of course, may be modified in proportion to the ratio of 100 cps to some other frequency at which this attenuation is permissible.

With pentodes, the cathode bias and screen-dropping resistances are chosen so that the stage will accommodate the largest output signal for 0.1 microampere grid current, and balanced overdrive into grid-current and cut-off regions. Cathode-bypass, screen-bypass, and coupling capacitances individually cause 10 per cent lower stage amplification at 100 cps than at mid-frequencies. Thus the relative gain at 100 cps will be down approximately 3 db per stage.

In some instances (particularly with low plate-supply voltages), the cathode-bias voltage resulting from such adjustment is so low that even with small input signals the distortion in amplification may be excessive due to nonlinear loading of a high-impedance source. Effects due to grid current and to contact potential within the tube are not completely described by chart data, because those measurements were made with low-impedance sources. In a cathode-biased amplifier with (say) 1.0 megohm grid resistor, a minimum instantaneous cathode-to-grid potential of 1.25 volts has been recommended to prevent grid current and resulting nonlinear distortion; that is, to avoid input loading by grid current, the grid current, the grid should not come closer to the cathode than about 1.25 volts if very high input impedance is to be maintained throughout the entire signal cycle. When cathode bias with chart component values is less than this figure, then for use with high source impedance, the circuit values would preferably be revised to fulfill this added requirement, even though voltage gain and maximum signal-handling capability are reduced thereby. Obviously, bias by contact potential alone (as with grounded cathode and very high grid resistor) is suitable only with source impedance low enough to be unaffected by appreciable nonlinear loading, or when lowest possible cost is of greater importance than lowest possible distortion.

When the cathode biasing resistor is left unbypassed, additional input signal is required to produce the same output voltage. The magnitude of degenerative voltage at the cathode is related to the input signal essentially by the factor $(A_v R_k)/(Z_L)$, where A_v is the amplification with cathode resistance R_k bypassed, and Z_L is the parallel resistance of the plate-load resistance and the grid resistance of the following stage. It follows that the stage amplification is reduced by the factor

$$Z_L/(Z_L + A_v R_k).$$

Readily calculable from chart values,

* *RCA Victor, Camden, N. J.*

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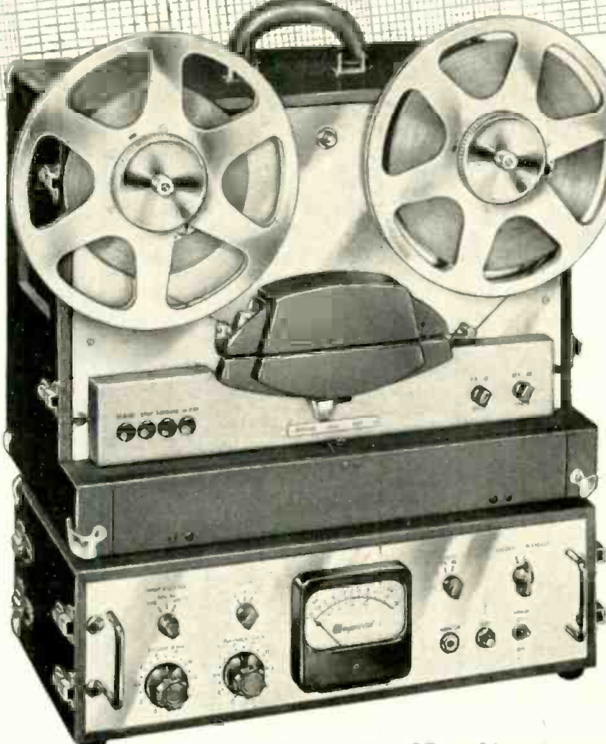

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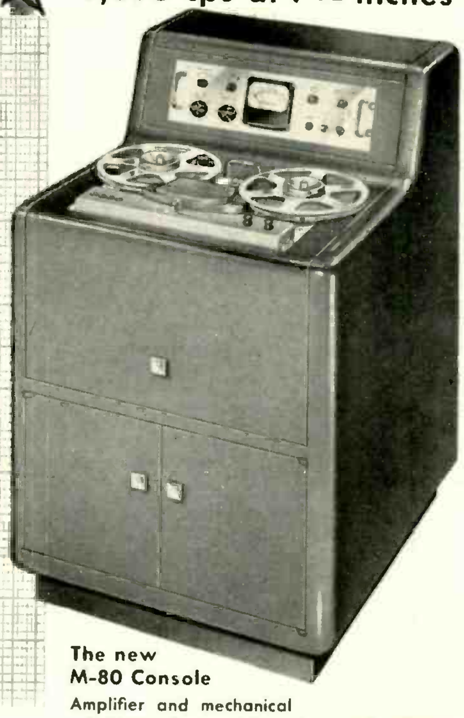

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the loss with cathode unbypassed is usually in the range from 3 to 6 db.

Often highest amplification is not needed, or component economy may be more important. Or perhaps the amplification of the stage must be uniform down to such a low frequency that a prohibitively large capacitance would be required. Some multistage amplifiers of quite high gain have no cathode-bypass capacitors whatever.

In pentode R-C coupled amplifiers, reduced amplification through omission of the screen-bypass capacitance is usually more like 20 db, which is such a large loss that screen bypassing is quite worthwhile.

At high frequencies, the response inevitably falls off because of shunt capacitances. With 0.5 megohm circuit impedance and 30 micromicrofarad total capacitance to ground, the high-frequency loss in amplification will amount to about 3 db at 10,000 cps (per such stage). For given shunt capacitance, wider bandwidth with constant amplification results from lower circuit impedance, so a pentode plate-circuit impedance (r_p, R_L and the following R_G, all in parallel) of 0.1 megohm or less is not uncommon in high-fidelity audio amplifiers.

In using triodes instead of pentodes as voltage amplifiers, the apparent advantage of lower plate-circuit impedance may be more than offset by the combined effects of lower amplification and higher input capacitance. The latter is due largely to the so-called Miller effect, due to feedback via the plate-to-grid capacitance. The magnitude of additional input capacitance due to this cause is approximately the grid-to-plate capacitance (tube, socket, and wiring combined) multiplied by the mid-frequency voltage amplification of the stage. Total resulting input capacitance is usually great enough to limit usefulness of high-mu triodes to situations in which the grid-to-ground capacitance is already very large, as with a long shielded input cable; or with a low-impedance source, such as a distribution line.

With either triodes or pentodes, nonlinear distortion is reduced through selection of the highest permissible resistance in the following grid circuit. For output signals up to 10 volts rms or so, harmonic distortion with a pentode amplifier can be much lower than with a triode operating with the same load resistances and supply voltages. This, coupled with the possibility of much smaller input capacitance, makes a quiet pentode such as 5879 or 1620 a particularly good choice for a low-level input stage. But when a grid-to-cathode signal having a magnitude of a volt (r.m.s.) or more must be accommodated, a triode voltage-amplifier stage is usually preferable. Tube type 12AU7 is very popular in such usage. When lowest possible hum or noise is sought, a better choice might be type 12AY7, or a triode-connected 5879 or 1620.

8 db more output

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BOOK REVIEWS

PHOTOELECTRIC TUBES, by A. Sommer. London: Methuen & Co. viii + 118 pages. A "Methuen Monograph on Physical Subjects."

This second edition has been retitled to indicate clearly that it covers photoelectric tubes, not photovoltaic nor photoconductive cells. Opening with an excellent statement of the theory of operation of photoelectric emission, (in a chapter written by S. Rodda) the book then proceeds to a description of photoelectric cathodes, the matching of light sources to particular cathodes, vacuum and gaseous types of tubes, the multiplier photocell, and finally a chapter on the application of photocells in general circuitry.

The treatment is one of a descriptive nature, rather than depending upon mathematical thesis, and is easily followed by the lay reader seeking a fundamental knowledge of this phase of electronic work. As the entire present day sound picture audio reproduction is dependent upon the photocell as a source of sound from the film, this text is clearly indicated to the neophyte in this field, whether he be entering upon it from a professional or amateur status. The twenty-seven diagrams, the bibliography, and the index are most complete in opening the door to further study of this subject for those whose particular interests are concerned.

—*L. B. Keim.*

BASIC ELECTRONIC TEST INSTRUMENTS, by Rufus P. Turner. New York: Rinehart Books, Inc. xiv + 254 pages illustrated, 1953. $4.00.

This revision of the same author's previous work in this field brings up-to-date the current status of test instruments in the radio and television field. Written for the practical service man, whose fundamental knowledge of electrical theory is assumed, the book not only describes the make-up of specific instruments but also their use in practical servicing. Where commercially built or kit-form testers are not available, specially designed instruments are described, based upon articles published by Mr. Turner.

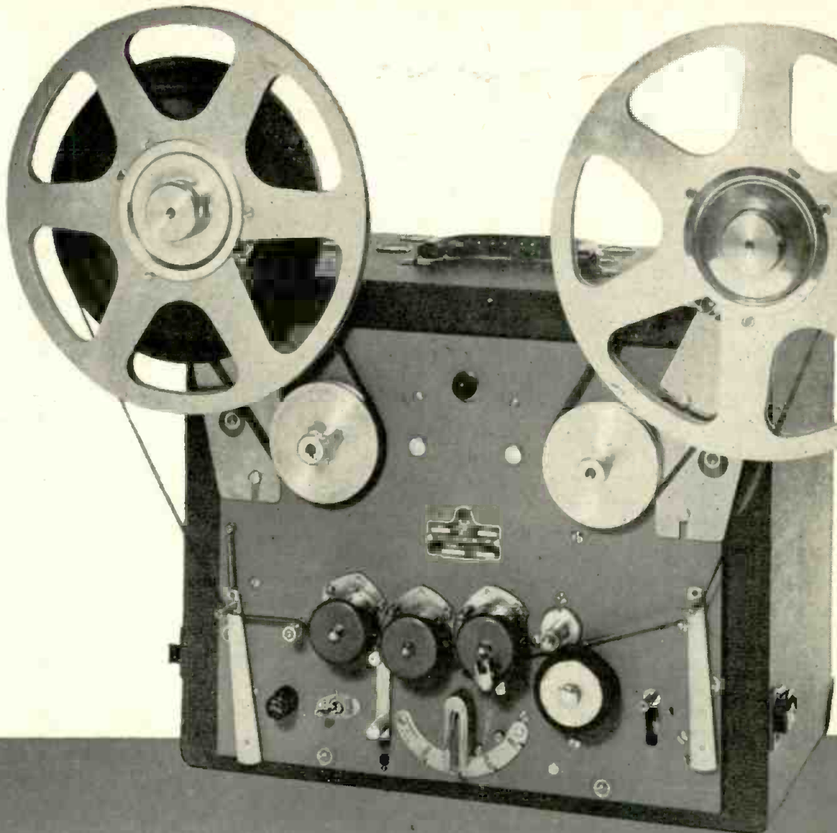
Beginning with basic meters and multitesters, power, impedance, capacitance, and inductance measurements are next covered. Special bridges, oscilloscopes, signal generators, both r.f. and a.f. follow in that order. Then several chapters on specific testing methods, including the use of signal tracing equipment, and finally a chapter on tube testing and tube checkers.

This author has had many years of practical servicing work, and he draws upon personal knowledge throughout his lucid writing style. The man primarily interested in audio work will find this good reading material as a fundamental step in the proper techniques of testing work. However, it must be noted that it is not fundamentally an audio treatise, but a guide for the general service technician.

One drawback from which this book suffers along with too many technical publications is the fact it is out of date before it reaches the reader, for while the techniques remain, most of the kit-form instruments described have been succeeded with newer and improved models. But for the man building a technical bookshelf on the easily understood basis, this book is ideally suited to his requirements for a text that is both clear in its statements and authoritative.

—*L. B. Keim.*

you don't buy one of **these** every day!



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EDITOR'S REPORT

AUDIO IN THE HOME

MANY OF Æ'S REGULAR READERS comment on the desire for more "butter on the popcorn"—an expression originated by Morgan Kennedy, Jr., 'way back in December, 1951. We try assiduously to comply with the desires of our readers, but all the while with the thought that Audio covers a very large field—not only for equipment used in the home, but also in the more professional aspects of the art or science, or both. Recognizing that not every reader is an engineer—nor even, perhaps, a hobbyist—we offer considerable material that can be understood readily by those who are not technically minded. We have often been criticized for including too much material of a highly technical nature, and we have been criticized just as often for including articles that were too "simple" to appear in a magazine with the word engineering in its title.

We know that audio covers a wide field—there are many readers who would be perfectly content to purchase a complete hi-fi system and then just enjoy it. We know too that there are many who buy a complete set of components and listen for a month or so and then start improving their home music reproduction by changing to a better amplifier, a speaker of wider range, or an enclosure with smoother output characteristics. There are many who build many of the components—there are those who engaged in custom installations—those who design and manufacture the components—those who work with professional equipment to provide us with the phonograph records and the radio broadcasts which are, after all, the source material for the home listener. In short, there are many kinds of people with many different kinds of interest in audio. We believe we must serve them all.

For the beginner in hi-fi, the descriptions of amplifiers and speaker enclosures and so on may seem complicated but, as everyone knows, there are many people who derive considerable pleasure from some form of handiwork. We think that a lot of the fun of audio is in making things, but the ultimate result—having high-quality sound reproduction in the home—is the aim of every music lover, and he can attain that goal just as well by buying completed units and putting them together himself, or even by buying a packaged hi-fi system—and probably a lot more quickly and economically. One of the advantages of "growing" a hi-fi system is that one can start with one exceptionally good unit—such as an amplifier, for example—and use it with the tuner portion of an existing radio set and, perhaps, a moderately priced speaker until he is ready to take another step. One does not need to get everything at once if the budget groans, but the normal procedure is likely to be that the radio set will be replaced with a good tuner, a good record changer and pickup will be added, and then possibly the speaker will be upgraded to a two- or three-way system.

But let us not be deceived by misleading suggestions from those who seek to capitalize on the current great interest in hi-fi. It is fairly well recognized that the finest speaker systems consist of two or three (or even four) units—each handling only a portion of the musical spectrum—but the presence of two or even three speakers does not automatically make a set hi-fi. Each component of a music system must be of high *quality*, and a system built of high-quality parts is almost certain to provide high-fidelity reproduction.

Howard Souther, of Electro-Voice, Inc., has prepared an interesting brochure on the components of a hi-fi system and the features to look for when making a choice of components for your own system. We felt that this material was well thought out and attractively presented, and accordingly we prevailed upon E-V to let us run it in this issue in its entirety for Æ's readers. Many of the illustrations indicate a predisposition on the part of the author for his company's products—as might be expected—but they are not mentioned by name. Some of Mr. Souther's ideas may be controversial, but in general the information is reliable. This section—fourteen pages —begins on page 54.

Letters containing your questions are coming in heavily for the Question and Answer page which will start with the December issue and continue regularly from then on. Remember, though—please include a stamped, self-addressed envelope.

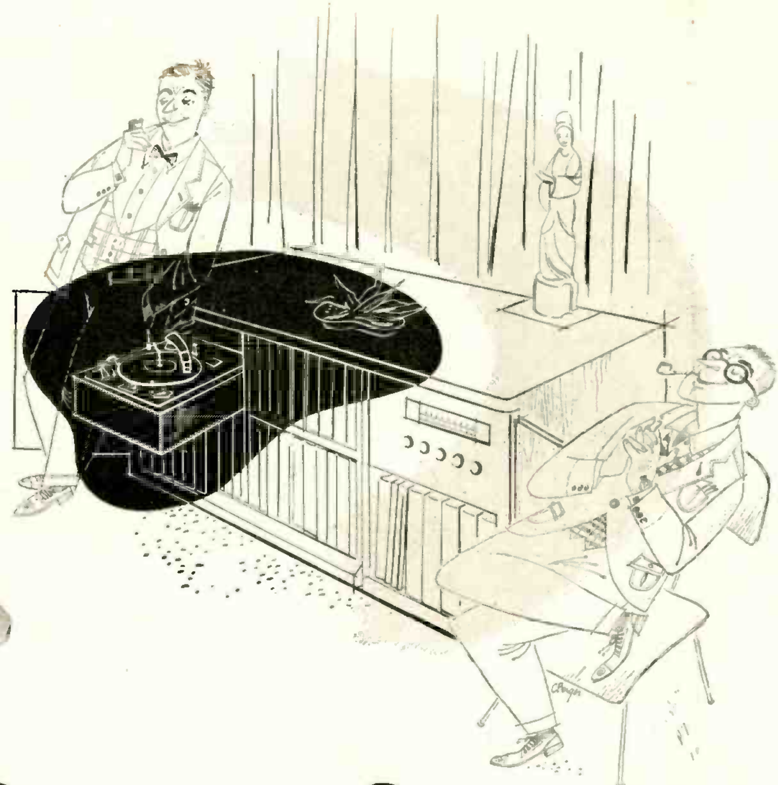
KEEP UP THE STANDARDS

At a meeting of the High Fidelity Committee of the RETMA held during the International Sight and Sound Exposition in Chicago, a task force was implemented to come up with definitions for *high-fidelity*. We most heartily agree that such definitions are needed—as did nearly everyone at the meeting—and it is expected that the task force will deliver at the Audio Fair. 'Til then, we await with interest.

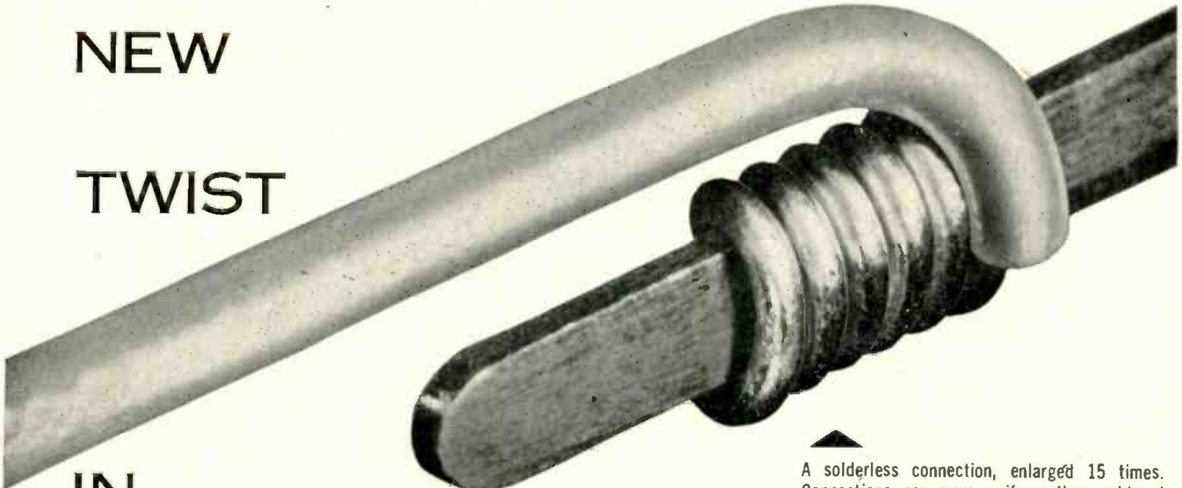
THE AUDIO FAIRS

Two Audio Fairs in two months make quite a chore for anyone in the audio business—even attending both during every minute the doors are open is wearing. The International Sight and Sound Exposition combined with the Audio Fair in Chicago introduced the Fair idea to the people of the Windy City—a city which was sweltering in temperatures ranging from 95 to 100 throughout the day and not much better at night. But still, according to the ISSE management, attendance was over 20,000 although it was estimated at somewhat less than that by experienced Fair attenders.

At least, New York Audio Fair has something to shoot at—at Los Angeles, the attendance was around 17,000 whereas NY's last figure was around 13,000. When it comes to attendance records, the first guy never has a chance.



A NEW TWIST IN TELEPHONY



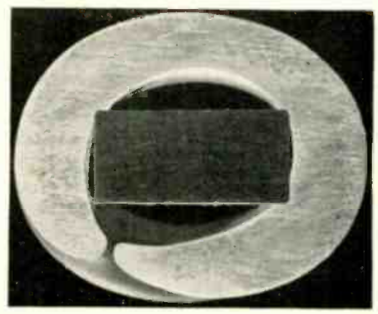
A solderless connection, enlarged 15 times. Connections are more uniform than soldered ones and only half as bulky.

For years the accepted way to connect wires to telephone apparatus was with solder. Now, Bell Laboratories engineers have discovered how to make connections faster and better—without solder.

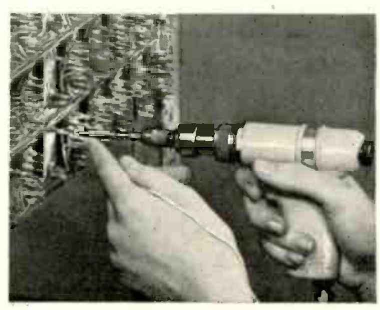
Solder, they reasoned, wouldn't be needed if wire and terminal could be kept tightly pressed together. But, for economy, this had to be done with the wire alone—without complicating screws and springs.

They found the answer in using a properly dimensioned terminal with sharp edges . . . whipping the wire around it under high tension. The terminal bites into the wire, locking it securely into position. Thereafter the squeezed edges maintain a contact pressure of at least 15,000 pounds per square inch—even under vibration that cracks soldered joints.

The new connections can be made in half the time—a big money-saver in the billion connections that Western Electric makes each year for the Bell System. It's another example of the way Bell Telephone Laboratories works continually to keep costs low.



Cross section of solderless connection. Note terminal biting into wire. In a six-turn connection there are at least 20 clean contact areas impervious to moisture and corrosive gases, offering current a low resistance path.



Power tool whips wire on terminal in fraction of a second. There is no heat which could damage miniature components . . . no dropped solder or wire clippings to cause trouble later.

BELL TELEPHONE LABORATORIES

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The Basic Design of Constant Resistance Crossovers

N. H. CROWHURST*

An analysis of the response and phase characteristics of constant-resistance crossover networks worked out for filters employing from one to four elements.

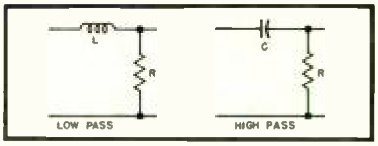

Fig. 1. Basic single-element filters for parallel combination at input into composite filter.

ALTHOUGH CROSSOVER FILTERS are now in everyday use, confusion about their design and performance still persists. Most presentations published to date concentrate attention on the filter-derived types. and if the constant-resistance variety is mentioned at all, it is just thrown in for good weight. In point of fact, the constant-resistance type of response offers several advantages over the filter-derived types.

When the parameters are correct for constant resistance, other useful properties appear that are not available with other derivations. The principal properties of these networks may be summarized as follows:

Attenuation Response

(*i*) The responses of the two filters, considered separately, are complementary, so that the sum of the energies delivered to the two output circuits, for constant-voltage or constant-current input (according to configuration), is constant at all frequencies.

(*ii*) Also the attenuation response of each filter gives the maximum flatness within its pass range, with the most rapid transition possible, with the number of elements used, short of introducing peaking in the vicinity of crossover.

Phase Response

(*iii*) The phase response of each filter is symmetrical about cut-off frequency (which is crossover for the combination).

(*iv*) The difference in phase between the signal delivered to the two outputs is constant.

* *150-46 18th Ave., Flushing 57, N.Y.*

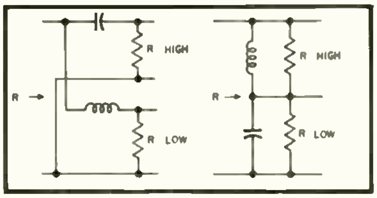

Fig 2. The two forms of composite filter, giving constant-resistance characteristics with single-element sectons. Each reactance is equal to R at crossover.

Input Impedance

(*v*) This, for the combined filters, is constant and resistive throughout the spectrum, provided, of course, that each filter is correctly terminated at its output. It is from this property of the filters that they derive their name.

This article will derive the formulas for constant-resistance filters using up to four elements in each filter, showing how the foregoing qualities apply for each case, and will consider the properties of simpler or more complex filters from the viewpoint of their effect on the fidelity of reproduction. At this stage, filters using physical inductances and capacitances will be assumed, but the theory developed will be useful for application to circuits simulating the responses by other means, to be considered later.

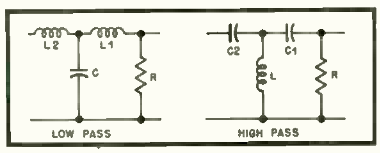

Fig. 5. Basic three-element filters.

For developing the formulas the filters will always be of such a configuration that their inputs are connected in parallel. The results are quite simply applied to filters of the type used for series combination by the principle of duality.

Single-Element Filters

Consider first the single reactance filters of *Fig.* 1, taking first the low-pass section. The relation between input and output voltage is

$$A_L = 1 + j\frac{\omega L}{R}$$

which can also be written

$$A_L = 1 + jx \qquad (1)$$

on the assumption that $\frac{\omega L}{R} = x$.

The energy supplied to the low-frequency unit is V^2/R, and V is E/A_L.

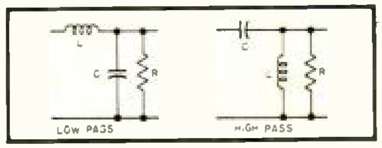

Fig. 3. Basic two-element filters for parallel combination at input to form composite filter.

So the energy supplied can be written

$$P_L = \frac{E^2}{R} \cdot \frac{1}{1+x^2} \qquad (2)$$

The attenuation response is given by

$$db_L = 10 \log_{10} (1+x^2) \qquad (3)$$

The phase relation between input and output is given by the angle whose tangent is the ratio between the real and imaginary parts of *(1)*. Using the convention that positive angles represent delay, the phase-transfer characteristic is given by

$$\phi_L = \tan^{-1} x \qquad (4)$$

The input impedance of the low-pass unit is

$$Z_L = R(1+jx) \qquad (5)$$

or, since it is to be connected *in parallel with the other unit,* the admittance is required,

$$Y_L = \frac{1}{R} \cdot \frac{1}{1+jx} = \frac{1}{R} \cdot \frac{1-jx}{1+x^2} \qquad (6)$$

Turning now to the high-pass section. The relation between input and output voltage is

$$A_H = 1 + \frac{1}{j\omega CR}$$

which can be written

$$A_H = 1 - j\frac{1}{x} \qquad (7)$$

on the assumption that $\frac{1}{\omega CR} = \frac{1}{x}$.

The energy supplied to the high-fre-

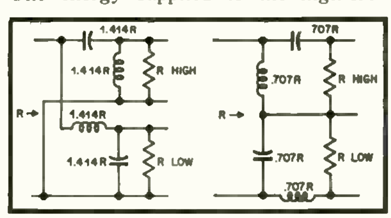

Fig. 4. The two forms of composite filter giving constant-resistance characteristics with two-element sections. Reactances at crossover are indicated.

quency unit can be written

$$P_H = \frac{E^2}{R} \cdot \frac{x^2}{1+x^2} \qquad (8)$$

and the attenuation response is given by

$$db_H = 10 \log_{10}\left[\frac{1+x^2}{x^2}\right] \qquad (9)$$

Adding together the energy supplied to the two units when the filters are paralleled, as given by (2) and (8),

$$P = P_L + P_H = \frac{E^2}{R} \cdot \frac{1+x^2}{1+x^2} = \frac{E^2}{R} \qquad (10)$$

This proves that condition *(i)* applies, i.e. the sum of the energies is constant. It might also be assumed to demonstrate condition *(v)*, because the denominator is R, but it is hypothetically possible to transfer this amount of energy without the input impedance being R, if there should be any reactive component to the input impedance, so this will be investigated.

The phase of the high-frequency output compared to the input is

$$\phi_H = \tan^{-1} - \frac{1}{x}$$

which can be transposed to

$$\phi_H = (\tan^{-1} x) - \frac{\pi}{2} \qquad (11)$$

It is seen that the difference between *(4)* and *(11)* is a constant angle of $\pi/2$ or 90 deg.

The impedance of the input to the high-pass unit is

$$Z_H = R\left(1 - j\frac{1}{x}\right) \qquad (12)$$

whence the admittance is

$$Y_H = \frac{1}{R} \cdot \frac{x}{x-j1} = \frac{1}{R} \cdot \frac{x(x+j1)}{1+x^2}$$

$$= \frac{1}{R} \cdot \frac{x^2+jx}{1+x^2} \qquad (13)$$

Adding together the admittances *(6)* and *(13)*, the combined input admittance is

$$Y = Y_L + Y_H = \frac{1}{R} \cdot \frac{1-jx+jx+x^2}{1+x^2} = \frac{1}{R} \qquad (14)$$

whence the input impedance is

$$Z = R \qquad (15)$$

which is constant, resistive, and equal to both output loads.

When $x = 1$, both P_L and P_H have half energy values, so this represents crossover frequency. Possible configurations using single-element filters are shown at *Fig.* 2. All reactances are equal to R at crossover frequency.

Two-Element Filters

The filter configurations for parallel connection at the input are shown at *Fig.* 3. For the low-pass section,

$$A_L = 1 + j\omega L\left(\frac{1}{R} + j\omega C\right)$$

$$= 1 - \omega^2 LC + j\frac{\omega L}{R} \qquad (16)$$

Using the same method as before, the energy supplied to the low-frequency unit will be

$$P_L = \frac{E^2}{R} \cdot \frac{1}{1 - 2\omega^2 LC + \omega^4 L^2C^2 + \omega^2 L^2/R^2} \qquad (17)$$

and the attenuation response is given by

$$db_L = 10 \log_{10}\left[1 - 2\omega^2 LC + \omega^4 L^2C^2 + \frac{\omega^2 L^2}{R^2}\right] \qquad (18)$$

To conform with conditions *(i)* and *(ii)*, *(17)* and *(18)* must reduce to the forms

$$P_L = \frac{E^2}{R} \cdot \frac{1}{1+x^4} \qquad (19)$$

and

$$db_L = 10 \log_{10}[1+x^4] \qquad (20)$$

respectively, which require $L^2/R^2 = 2LC$ and $\omega^2 LC = x^2$. These equations are satisfied by making

$$\frac{\omega L}{R} = \sqrt{2}x \text{ and } \frac{1}{\omega CR} = \frac{\sqrt{2}}{x} \qquad (21)$$

Substituting these values into *(16)* gives

$$A_L = 1 - x^2 + j\sqrt{2}x \qquad (22)$$

Applying this to the phase response,

$$\phi_L = \tan^{-1}\frac{\sqrt{2}x}{1-x^2} \qquad (23)$$

and the input impedance of the low-pass unit is

$$Z_L = R\left(j\sqrt{2}x + \frac{\sqrt{2}}{\sqrt{2}+jx}\right)$$

$$= R\left(\frac{\sqrt{2}(1-x^2)+j2x}{\sqrt{2}+jx}\right) \qquad (24)$$

From which the admittance is

$$Y_L = \frac{1}{R}\left(\frac{\sqrt{2}+jx}{\sqrt{2}(1-x^2)+j2x}\right)$$

$$= \frac{1}{R}\left[\frac{2-j\sqrt{2}(x+x^3)}{2(1+x^4)}\right] \qquad (25)$$

Turning to the high-pass section,

$$A_H = 1 - \frac{1}{\omega^2 LC} + \frac{1}{j\omega CR} \qquad (26)$$

The energy supplied to the high-frequency unit will be

$$P_H = \frac{E^2}{R} \cdot \frac{1}{\left(1-\frac{1}{\omega^2 LC}\right)^2 + \left(\frac{1}{\omega CR}\right)^2}$$

$$= \frac{E^2}{R} \cdot \frac{\omega^4 L^2C^2}{\omega^4 L^2C^2 - 2\omega^2 LC + 1 + \omega^2 L^2/R^2} \qquad (27)$$

and its attenuation response

$$db_H = 10 \log_{10}\left[1 - \frac{2}{\omega^2 LC} + \frac{1}{\omega^4 L^2C^2} + \frac{1}{\omega^2 C^2R^2}\right] \qquad (28)$$

which should take the form

$$P_H = \frac{E^2}{R} \cdot \frac{x^4}{1+x^4} \qquad (29)$$

and

$$db_H = 10 \log_{10}\left[\frac{1+x^4}{x^4}\right] \qquad (30)$$

requiring the same values as given in *(21)*.

Condition *(i)* is seen to apply by adding *(19)* and *(29)*:

$$P = P_L + P_H = \frac{E^2}{R} \cdot \frac{1+x^4}{1+x^4} = \frac{E^2}{R} \qquad (31)$$

Substituting the values of *(21)* into *(26)* gives

$$A_H = 1 - \frac{1}{x^2} - j\frac{\sqrt{2}}{x} \qquad (32)$$

This gives the phase response as

$$\phi_H = \tan^{-1}\frac{-\sqrt{2}x}{x^2-1}$$

which can be transposed to

$$\phi_H = \left(\tan^{-1}\frac{\sqrt{2}x}{1-x^2}\right) - \pi \qquad (33)$$

from which it is seen that the phase difference between *(23)* and *(33)* is constant at π or 180 deg.

The input impedance of the high-pass unit is

$$Z_H = R\left(\frac{j\sqrt{2}x}{1+j\sqrt{2}x} - j\frac{\sqrt{2}}{x}\right)$$

$$= R\left(\frac{2x+j\sqrt{2}(x^2-1)}{x(1+j\sqrt{2}x)}\right) \qquad (34)$$

and the admittance is

$$Y_H = \frac{1}{R}\left(\frac{x(1+j\sqrt{2}x)}{2x+j\sqrt{2}(x^2-1)}\right)$$

$$= \frac{1}{R}\left(\frac{2x^4+j\sqrt{2}(x+x^3)}{2(1+x^4)}\right) \qquad (35)$$

Thus, by adding *(25)* and *(35)*, it is seen that the combined input admittance is $1/R$, as before, and the input impedance is equal to the load connected to each output and is always resistive.

Possible configurations using two element filters are shown at *Fig.* 4, with the reactance values at crossover frequency.

Three-Element Filters

Figure 5 shows the basic three-element filters for parallel combination at the input.

By similar development, it may be shown that the energy delivered to the low-frequency unit is

$$P_L = \frac{E^2}{R} \cdot \frac{1}{1+x^6} \qquad (36)$$

and the attenuation response is

$$db_L = 10 \cdot \log_{10}(1+x^6) \qquad (37)$$

respectively to fulfill conditions *(i)* and *(ii)*.

The phase response is given by

$$\phi_L = \tan^{-1}\frac{2x-x^3}{1-2x^2} \qquad (38)$$

The corresponding expressions for the high-pass unit are

(Continued on page 108)

Complete Remote Control of an Ampex 300

RICHARD F. BLINZLER*

Remote operation of a standard tape recorder facilitates use by a number of studios without need for a separate recorder operator, and provides greater flexibility for small studio.

Fig. 1. Cam lever switch mounted on the front panel of an Ampex 300 tape recorder in place of the rotary switch. Switch-handle motion is forward and backward, but name plate had not been changed.

THE REGULAR REMOTE CONTROL circuit used on the Ampex 300 tape recorder allows remote operation of the START, STOP, and RECORD switches. If it were possible to extend remote operation to the circuits controlling fast forward, play, and rewind, almost complete remote control of this machine would result. These functions are normally set by a rotary switch on the front panel of the recorder.

Merely extending these switch wires, eight in all, would not provide proper remote operation because the switch remains in whatever position it is set and so some of the switches might be set in the wrong position for other remote operation.

Study of the FAST FORWARD-PLAY-REWIND switch showed that its operation could be duplicated using a cam lever switch to control two relays. On the recorder the rotary tap switch controlling these modes of tape travel was removed and a DPDT cam lever switch was mounted in the same hole.

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Figure 1 shows the cam lever switch mounted in place of the rotary tap switch on the front panel of the recorder; *Fig.* 2 shows the new relay assembly and the rear of this lever switch as mounted inside the recorder on the shelf supporting connecting plugs and fuses; and *Fig.* 3 is a simplified schematic of the modification.

The Ampex instruction book (Control Circuits, Models 300-301-302, dated Jan. 15, 1952) shows resistors R_{801}-R_{802}-R_{803} and the rotary tap switch which control

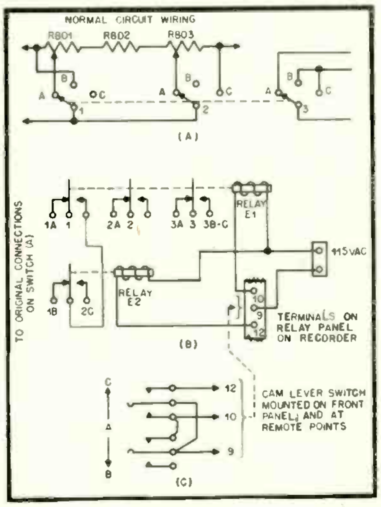


Fig. 3. Wiring schematic inside Ampex 300 recorder to permit remote operation. (A) shows normal wiring of PLAY-REWIND-FAST FORWARD switch; (B) shows connections to two relays E_1 and E_2; and (C) shows connections to the cam lever switch mounted in hole formerly occupied by rotary switch. All remote switches are also connected to the three terminals—9, 10, and 12.

the tape transport mode switch—i.e., fast forward-play-rewind functions. *Figure* 3 shows these parts and below them the two new relays and the cam lever switch.

On REWIND, relay E_1 coil is energized. On FAST FORWARD operation both E_1 and E_2 are energized. On PLAY, both relays are de-energized. In the PLAY position ("A" on the rotary switch), the 3PDT relay, E_1, on its normally closed back contacts connects 1 to 1A, 2 to 2A, and 3 to 3A. On REWIND ("B" on the rotary switch) the make contacts of E_1 connects 1 to 1B, through contacts on relay E_2, and 3 to 3 B-C. On FAST FORWARD E_1 operates as described except that 1 connects to 2C through contacts of E_2.

The operation of these relays can easily be remotely operated by the addition of three wires to the regular remote control circuits and a cam lever switch at each remote position.

Any number of remote positions can be added because all of the remote controls, both regular and this modification, are parallel circuits with the one exception which is the series connected STOP control.

Advantages of this remote operation is that the lever switch in its normal "hands-off" operation remains in the PLAY position and it is impossible for the recording engineer, as in the past, to leave the recorder with the transport switch in the wrong position and so possibly rewind off the reel instead of the desired operation.

The START button may be held down while the switch is thrown rapidly for shuttle operation of the tape *but* if it is

(*Continued on page 116*)

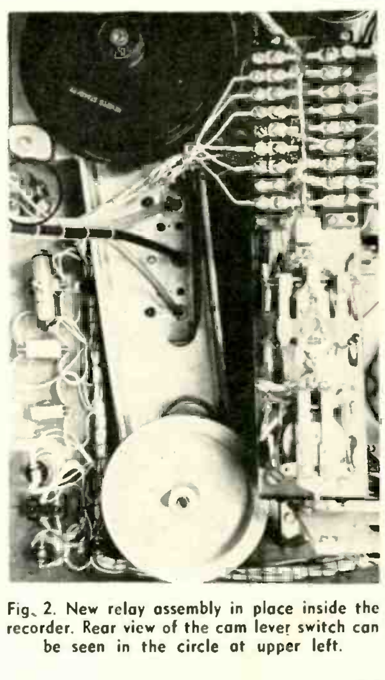
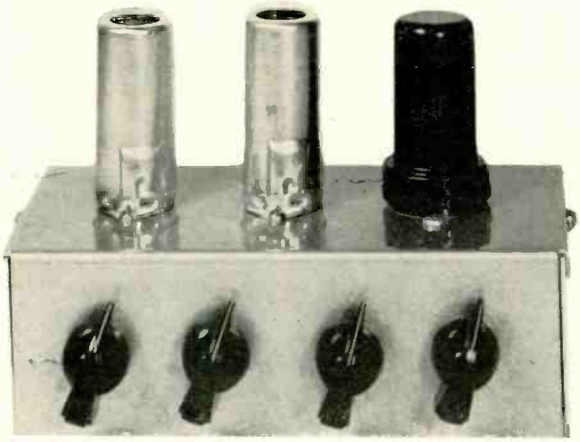


Fig. 2. New relay assembly in place inside the recorder. Rear view of the cam lever switch can be seen in the circle at upper left.

A Three-Element Bass Control

GLEN SOUTHWORTH*

One solution to the problem of providing realism in music reproduction is to introduce a controlled amount of "hangover" by means of the circuit described which permits boosting bass at three separate frequencies independently.



The three-element bass tone-control unit designed to obtain power supply from main amplifier.

In the design of conventional tone controls a cut and dried procedure is very often followed. A sine-wave test signal is used and the circuitry adjusted to provide the desired number of decibels boost or cut in reference to 1000 cps, typical steady state response curves being shown in *Fig.* 1. While very useful in many cases, this type of tone control is not very likely to provide adequate compensation for some program sources as well as the listener's speaker system, room acoustics, and individual musical tastes.

The bass-boost circuitry described in this article is an attempt to provide a musical form of bass emphasis similar to the kind generated naturally by good acoustics. To do this, particular attention has been paid to the transient character of most bass sounds as well as some of the significant factors of human hearing. The results obtainable should be highly valued by the listener who desires good, full, audible and "feelable" bass together with a minimum of interaction or apparent distortion of high frequencies.

Figure 2 shows three of the most commonly used methods of bass boost. These are the R-C network, the R-C-L or resonant circuit, and the inverse-feedback method of obtaining bass emphasis. A fourth type of frequency emphasis is obtained by altering the feedback path of a triode or pentode in such a manner that the circuit simulates a resonant inductance-capacitance combination. Though more complicated than the LC circuit of (B) in *Fig.* 2, This circuit has a number of distinct advantages. It requires no expensive high-Q inductances, and is therefore not susceptible to hum pickup from stray magnetic fields. Likewise, it is a high-impedance device with essentially zero insertion loss and as such is easily adapted to, or combined with, other audio circuitry. In addition, control of the circuit is very flexible and apparent Q's from zero to near infinity may be obtained by varying the setting of a single potentiometer.[1]

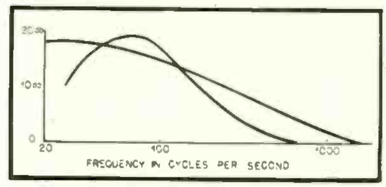


Fig. 1. Comparative steady-rate response curves of conventional bass-boost circuit (A) and resonant bass boost (B).

The steady-state response curves of a simulated resonant circuit are shown in *Fig.* 1 in comparison with those of a conventional tone control. Two factors are worth noting: First, that the curve obtained is such that added accentuation is obtained in the low-bass region where it is frequently needed to compensate for poor speaker and baffle efficiency, inferior acoustics, and possible defects in original program material. Secondly, the response can be made to drop off quite sharply below a chosen frequency in order to reduce the possibility of amplifier or speaker overload by very-low-frequency components, or in some cases to attenuate serious hum

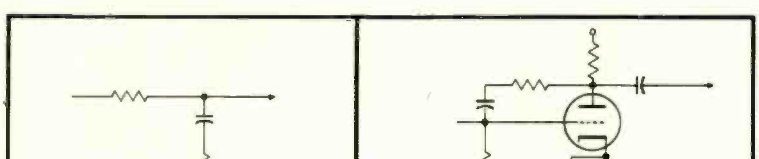


Fig. 2. Bass-boost circuits—(A) is the resistance-capacitance circuit; (B) is the resonant circuit, usually low impedance; (C) is the feedback type of bass equalization; and (D) is the simulated resonant circuit, with frequency determining elements shown in dotted box.

* *Box 284, Moscow, Idaho.*

[1] "Artificial hangover." *Radio and Television News*, January, 1952.

in the program material.

Steady-state measurements tell only part of the story, and in many cases the transient response characteristics will be more important in determining what the reproduced bass sounds like. *Figure* 3 shows a series of scope photos illustrating the effects of various types of bass circuits on transient pulses. In the case of the synthetic resonant circuit, nearly pure bass fundamentals are generated from the transient pulses not only at the main resonance frequency, but for an appreciable range on either side.

The synthetic construction of fundamental tones from transient pulses may be considered to give the following benefits. It tends to duplicate effects produced naturally by good acoustics, it tends to provide a signal more easily reproduced by present day speakers, and—rather paradoxically—it can result in better apparent highs. This last characteristic is a psycho-acoustic effect resulting from the fact that the masking characteristics of the low-frequency reproduction are radically changed. As a result, more bass boost can be used without drowning out the highs with strongly masking pulses or noise components. At the same time it may be found that certain transients become semi-audible that were not reproduced at all previously and these give a softening and more musical effect to what might otherwise be strident highs.

Fig. 4. Three-element bass-boost circuit with self-contained power supply.

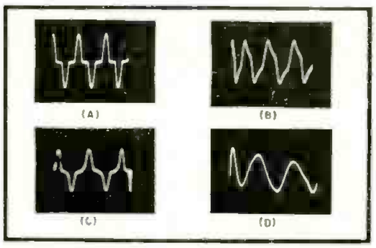


Fig. 3. Oscilloscope photos showing pulse series with repetition rate of 100 cps. (A) shows initial pulse shape; (B) shows output of R-C bass-boost network such as that of (A) in Fig. 2; (C) illustrates output from feedback type of boost circuit; and (D) is 'scope trace of output of the three-element bass-boost circuit.

In addition to its pulse-forming characteristics, the resonant circuit has another aspect that has suffered considerable misunderstanding. This is the fact that a high-Q circuit will generate "hangover" when shock excited. Unfortunately, hangover has come to be associated with a host of undesirable distortions in bass reproduction, and as a result, resonant circuits have been little used in recent years. Actually, a thumpy or boomy reproducing system is apt to be suffering from too little hangover rather than too much. The reason for this is that rapidly damped wave trains produce strong "side-bands," or adjacent frequencies, and the ear tends to hear and be irritated by the spurious high-frequency components of a too-rapidly damped bass note. Similarly, adjacent resonances in the speaker, baffle, or acoustics tend to be strongly stimulated and consequently may produce disagreeable beats.

The introduction of artificial hangover before the loudspeaker means several things. Short duration wave trains are lengthened and non-symmetrical components are largely eliminated, with the result that an objectionably pitched speaker or cabinet resonance is much less apt to be stimulated. Similarly, fewer spurious sidebands are produced, with the result that the listener hears deeper and clearer bass. This last may be considered of definite importance when listening at low levels due to nonlinearity of the ear which gives the effect of heavily damped wave trains. However, certain precautions should be taken to secure optimum results with resonant bass boost circuits. In the average phonograph, there are apt to be three major sources of mechanical resonance in the bass region. These are the loudspeaker, the speaker cabinet, and the phonograph pickup arm, and sometimes the proper combination of these elements can result in a system with warm, vibrant, bass without electrical boost. However, if the electronic resonance is peaked at or near the frequency of one of the mechanical resonances very disproportionate response may occur.

Practical Circuit

Figure 5 shows the schematic of a bass-boost circuit which employs three different resonant elements. By using two or more resonant elements in the bass region the over-all response may be more closely compensated for and tendencies toward "one-note" reproduction are greatly reduced. In the circuit shown, each control serves a dual purpose, acting as a means of controlling the "Q" of the resonant element as well as an attenuator of that particular channel. Thus, when the three bass controls are turned all of the way down, no bass boost occurs. When the controls are turned part way up, a low "Q" resonance is simulated and pulse forming occurs. When the controls are turned all the way up, a high "Q" resonance is simulated and artificial hangover occurs. The fourth control shown is the input level to what is called a "side amplifier," a channel which introduces no frequency discrimination, and which

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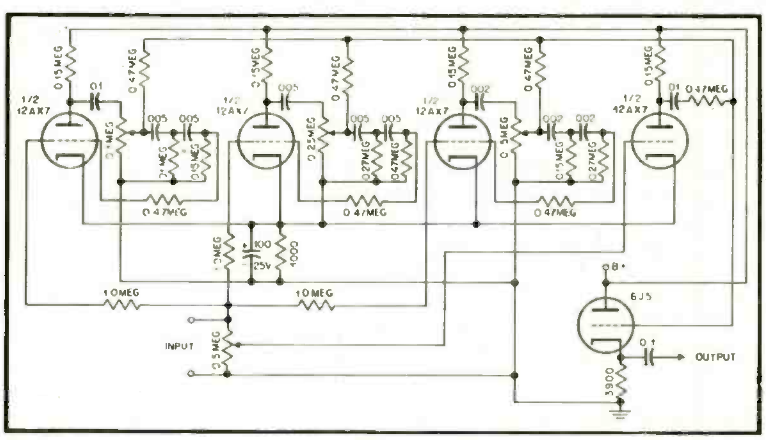

Fig. 5. Schematic of tone control system using three different simulated resonant elements, a side amplier, and a cathode-follower output. Note that no over-all volume control is included. Resonant frequencies are 45, 80, and 120 cps.

Photo Courtesy Steinway & Sons

The Piano

ALBERT PREISMAN*

In Two Parts—Part I

The author discusses the history, construction, and tonal characteristics of the piano—the most universal of the musical instruments.

At the conclusion of a Horowitz recital, one enthusiastic member of the audience was overheard saying to his friend, "I'll come any time to hear that guy. He's a one-man orchestra!" I certainly do not wish to detract from Horowitz's ability as an artist, but some of the credit should go to the instrument he plays: the piano.

The piano is the orchestra for the home; it is a complete musical instrument in itself. Although unaccompanied pieces and suites have been written for the violin, and it is capable of playing double-stops and chords (after a fashion), it is the piano that can stand by itself or cooperate with other instruments, either as an accompanying instrument—such as for the voice or violin—or as a solo instrument, as in a piano concerto.

* *Capitol Radio Engineering Institute, Washington, D. C.*

The organ is an even more complete instrument in this respect, but it is a much bulkier and more elaborate device, and hardly suited for the average home. True, we must not overlook the new electronic versions, which are much more compact and eminently suited for home use, but the piano will probably continue to be one of the most popular musical instruments that are to be played rather than to be listened to.

History of the Piano

The Clavichord.—The piano is a stringed instrument, and took on its present form in about 1709. But prior to this, perhaps as early as 1323, there was the clavichord, which consisted of a number of strings, and an even greater number of keys or *claves,* which had tangents that not only struck the string, but also determined its vibrating length and hence its pitch. Thus, more than one key was assigned to a string; each key produced a tone of different pitch. The disadvantage of this arrangement is that certain chords could not be played because the keys comprising this chord happened all to act on one string.

The Harpsichord.—The Middle Ages had given rise to a form of string instrument known as the psaltery, in which the strings were plucked. From this was derived a series of instruments known as virginals, spinets, and harpsichords. In these instruments, a jack at the base of the key had a small quill or leather tongue projecting horizontally from it. When the key was depressed, its rear end and jack jumped up, and the quill or tongue side-swiped the string and plucked it. The resulting tone was a characteristic twang, of fixed intensity.

The square form of instrument, in which the strings ran from left to right, was known as the spinet (abbreviated from *strumento da spinetta,* or instrument with quills or thorns). Another form had the strings running vertically, like in the modern upright pianos, and a third form had the strings running from front to back, like in a modern grand piano. This form was shaped like a harp, and hence was called a harpsichord.

The square and grand form were also originally known in England as virginals, probably derived from the Latin word *virga,* which referred to a rod or jack. The term was generally used in the plural—thus, "a pair of virginals." There has been some revival in interest in the harpsichord, but the instrument has undoubtedly been superseded for good by the piano.

THE PIANO.—The piano is in a sense a return to the clavichord, in that the string is struck rather than plucked, but the important difference is that the string is struck by a hammer that immediately rebounds, leaving fixed stops to determine the pitch. It was invented by an Italian, Cristofori by name, in about 1709, when he furnished a diagram of the action.

He called his instrument *"gravicembalo col pian e forte,"* which means large harpsichord able to produce soft and loud tones depending upon the touch. The word piano is of course an abbreviation of this longer name. No longer was the loudness fixed, as in the harpsichord (except for complicated attachments); the piano allowed much greater degrees of expression and interpretation.

The Germans began to manufacture pianos, with variations on Cristofori's original hammer action. However, the results were not particularly good, especially since the Germans preferred to stick to the clavichord form; and it is to England that we must look for a more mature development of this instrument. It was here that the famous house of John Broadwood originated, and it was in England that the various stops and controls of the German pianos were reduced to the two modern pedals: the forte, in which all dampers are removed from the strings; and the piano, in which the hammers are shifted laterally so as to strike *una corda* (one string) of the two tuned to a given pitch.

France is distinguished by an Alsatian

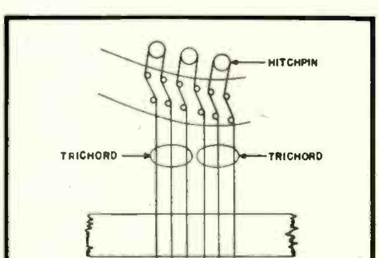

Fig. 3. Showing how one length of wire serves for two springs.

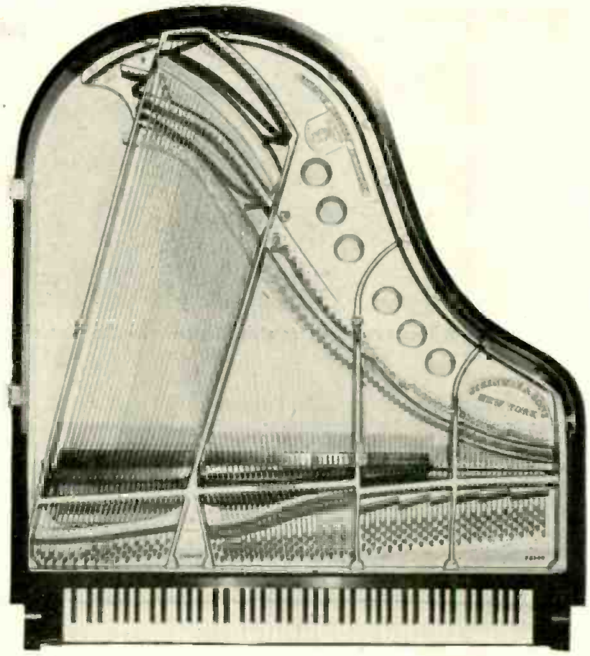

Fig. 1. Top view of the soundboard braced with the cast-iron plate, showing method of overstringing. (Courtesy Steinway & Sons)

piano maker, Sebastien Érard, who devised a key action which permits a note to be repeated more rapidly and with more force than even Cristofori's action did. Thus, after the hammer strikes the strings and bounces back, it is caught in mid-air and held closer to the string than when normally at rest, so that it can strike the strings more quickly when

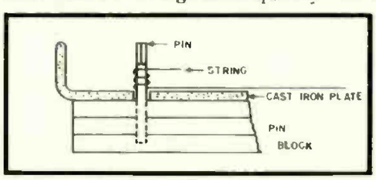

Fig. 2. Pin-block or wrest-plank, tuning pin, and string.

the key is pressed again. Érard also invented the *agraffe,* a metal stud pierced with holes, one for each string of a key, and which held the strings in place under the impact of the hammer.

The more modern history of the piano starts with Heinrich Engelhard Steinweg, born in Wolfshagen in the Harz mountains in 1797 to a humble forester already blessed with fifteen children. Of all of these, only Heinrich survived the vicissitudes which followed, and he even came through the battle of Waterloo unscathed; indeed, even won a medal for bugling without faltering while the battle raged!

He returned to go into the cabinet-making trade in an organ factory, and when he married Juliane Thiemer, constructed as a wedding present to his bride, a new kind of piano with two strings to each note. The birth of their first child, C. F. Theodor, called for a new piano with three strings per note, and which took fourteen years to build. Theodor won first prize in a recital at the State Fair, and that led Heinrich to decide to become a piano manufacturer.

The revolution of 1848 led another son, Charles, to flee to America; the rest of the family of ten followed to New York. Here Heinrich Steinweg became Henry Steinway, and Steinway and Sons became the firm known throughout the world.

One of the first improvements was the combination of the cast-iron frame with over-stringing in 1859. The cast-iron frame, on which the strings are stretched, was invented in America in 1833 by Conrad Meyer; the combination of over-stringing of the bass strings with such a frame revolutionized piano designs. Other innovations or improvements were the diaphragmatic soundboard and the accelerated action, but perhaps the most important characteristic of a Steinway or other fine piano is painstaking care, both in the choice of materials and in the construction of the instrument.

In the city of Cincinnati, Ohio, the Superintendent of Music in the Public Schools, Dwight Hamilton Baldwin by name, decided one day in 1862 to open a small piano store on the corner of Fifth and Elm Streets. He was a well known music teacher in the Ohio Valley, and his enterprise flourished to the point where he began to manufacture his own piano, the Baldwin. Today, the Baldwin piano is well known and highly esteemed throughout the world; from the humble beginning just mentioned in a small second-story office, the Baldwin Company has expanded to a modern factory of half a million square feet of floor space, and the company maintains retail stores in major cities from coast to coast, as well as outlets through leading music dealers everywhere.

The family of Lucian Wulsin, who in 1865 became D. H. Baldwin's bookkeeper and later his first business partner, has been in active control of the company for several generations in a manner similar to that of the Steinway

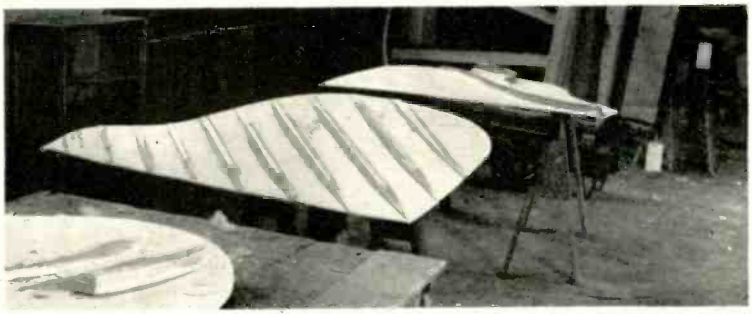

Fig. 4. Details of the soundboard for a small grand piano. (Courtesy The Baldwin Piano Co.)

family. It is of interest to note that two of the leading piano manufacturers are in the hands of private families rather than impersonal corporations.

There are, of course, other famous names in piano history, such as Bechstein, Bluthner, Broadwood, Chickering, Mason and Hamlin, and Knabe, but we shall conclude this brief history of the piano and proceed to other features of this instrument.

General Features of the Piano

Basic Components.—There are at least five basic components of the piano:

(1) The strings, which are strung across
(2) A cast iron frame or plate, in turn supported and reinforced by
(3) The frame of the wooden case;
(4) The soundboard, against which which the strings press via a structure called the bridge, and which radiates the vibrational energy into the air more effectively than the strings do, because of the low radiation resistance of the latter; and
(5) The action, which includes the keys and the felt hammers as well as the intervening linkages and mechanism, and which enables the player's hands to set the strings into vibration by the percussive effect of the hammers.

It will be of interest to study how these components are constructed and their basic behavior before we discuss some of the finer points of their action.

The Strings.—The strings are the primary source of the tone. They are made of special high-carbon steel: piano-wire is noted for the quality of its material. The string diameter varies from .030 in. to about 0.067 in. As we shall see later, one reason for the superior, more brilliant tone of the modern piano is the fact that the strings are under greater tension, which has been further increased by the rise in the pitch of standard A to 440 cps in the last century.

Mention was made previously that as many as three strings are employed in unison for a single tone. This is true in the treble, where the tone is inherently feeble, and three strings can absorb the hammer blow more efficiently and hence yield a greater acoustic output.

In the upper part of the bass register, two strings tuned in unison are sufficient, and in the extreme lower bass section, a single string per key is employed. In order to obtain a vibrating system having a higher Q—that is, one having a greater ratio of stored to dissipated energy—it would be necessary to employ an inordinately long string in the bass register in order to be able to operate it under sufficient tension and yet have it tuned to the desired low pitch.

Hence, the well-known expedient of loading is employed: the steel-wire core is wound with a tight helix of copper or iron wire, as the case may be. Usually the machine for doing this is specially built by the piano company. The core wire is looped around a rotating shaft in a lathe-like machine, and the other end fastened to a spindle at that end. The wire is then swaged at each end by hammering it on an iron block directly under it. This makes the wire have a square cross section at those points, so that the ends of the helical wire coating will obtain a purchase on the core wire.

One end of a spool of, say, copper wire is then wrapped around the swaged part at the left end, and any surplus skillfully broken off. The core wire is then set into rotation, and the copper wire carefully wound on it by the use of a carriage, or by hand in the case of the heavier wire. When the helix reaches the right-end swaged portion of the core wire, the machine is stopped, and the copper wire broken off from that remaining on the reel. The hand is preferred for the heavier wrapping wire because the wire is too heavy for the carriage: it is important that the helix be absolutely uniform if the string is to vibrate true, particularly as regards the overtones.

The action of the copper wire loading may be explained as follows: As we shall see later, the string can be regarded as a transmission line, approximately open-circuited at its two ends. The loading, being in the form of a helix, cannot withstand any longitudinal stress or tension, hence it does not assist the core material in resisting the tension pull of the end pins when they are rotated to tune the string.

In other words, the loading merely adds to the mass of the string, without affecting its ability to withstand stretching, as would be the case if a solid wire of the same diameter were used. Thus, we may regard loading as equivalent to increasing the unit inductance, only, of a transmission line. This would tend to lower the resonant frequency of the line. To compensate, its unit capacitance must be reduced. This is accomplished mechanically by increasing the tension of the string, thus bringing it back up to the desired pitch, and with a Q higher than the unloaded string.

The advantage of loading in the form of a helix over using a solid wire of the same diameter is that the latter has too much stiffness to bending other than that due to tension. Later on it will be shown that such stiffness tends to produce inharmonicity in the string, with resultant unsatisfactory tone qualities.

Loading, then, enables a shorter bass string to be put under greater tension for a desired pitch. It therefore is particularly useful in the case of the smaller baby-grand and spinet pianos. However, so much loading is required, particularly in the case of the latter, and the wire is so short that its inherent stiffness becomes appreciable, and the result is inharmonic overtones, as well as very little output of the fundamental bass tone.

One of the most important design features of a piano is the scaling of string lengths. This is a very specialized art;[1] and much of the piano tone depends upon skillful use of its principles, particularly in the case of the smaller pianos, such as the spinet.

If the tension and mass per unit length of a string are maintained constant, the fundamental frequency of vibration varies inversely as the length. Thus, to obtain a tone one octave lower, the string should be doubled in length. Actually, the string length does not quite double for an octave decrease, but instead increases by a factor of about 1⅞ or so.

For the same tension, the frequency would therefore be somewhat too high, but this is compensated for by using a heavier gauge of wire. This in turn permits the longer string to resist better the deforming effect of the hammer blow, and also enables a uniform rule of length increase to be employed to a much lower note before the string becomes too long for the size of the piano. From this point on, of course, the strings are loaded and their lengths are considerably shorter than 1⅞ times those of strings one octave higher.

Actually, the increase in wire gauge results in the lower strings being under greater tension than the treble strings. This is desirable in that but one or two strings are used in unison in the lower range, as against three in the upper range; the change in tension helps to compensate so as to make the stress more nearly uniform for all parts of the plate. In passing, we note that the highest treble strings have an effective length of about two inches.

The Plate.—*Figure* 1 shows a cast-iron plate, as used in a grand piano. Ob-

[1] W. B. White, "Problems of a stringing scale for small vertical pianofortes." *J. Acous. Soc. Am.*, Vol. 12, p. 409, 1941.

serve first how the bass strings on the left cross over those of the middle register, so as to obtain greater length in a given size frame. This is known as overstringing. At the keyboard end, of course, all the strings run from left to right as one goes up the scale; this is in order that the keys and action will form a similar left-to-right sequence. But the others ends of the strings do not have to follow in such sequence, and overstringing is therefore possible, with the advantages that accrue to longer bass strings.

Note in *Fig.* 2 that the ends of the strings are looped through and around steel tuning pins. Those at the keyboard end are not fastened into the cast iron plate, but are driven into a laminated maple board beneath it. This board is known as the "pin-block" or the "wrest-plank."

The tuning pin is a steel rod normally .280 in. in diameter (although it also comes in larger sizes), with a square top portion to engage the tuning hammer, and a hole beneath this square portion through which the spring passes and then winds around. The lower end of the pin has a very fine and light thread in it, so that it can be screwed out of the hole drilled in the pin-block into which it was initially driven.

This thread increases the frictional contact with the pin-block and prevents the taut string from revolving the pin and thus detuning itself. Hence, for a piano to hold its tune, the pin must fit firmly in its hole, but not so tightly that it cannot be smoothly turned by the tuning wrench. This, in turn, means that the holes must not be drilled too rapidly in the pin-block lest they become somewhat oversize. Moreover, if the wood chars slightly owing to the drilling being too rapid, the pins will move in a series of jerks, which renders tuning very difficult if not impossible. Here we have a good example of the time-consuming operations required in constructing a really fine piano.

But to return to the cast-iron plate. Each string is under a tension of about 160 pounds, average, and since there are approximately 230 strings, the total pull on the plate is between eighteen and twenty tons. Brittle cast iron is sufficiently rigid to withstand such great forces without creeping, and therefore normally used as the plate on which the strings are strung. As we shall see, the string vibration is transmitted to a spruce soundboard, which acts as the principal acoustic radiator, and the plate acts presumably as the frame that withstands the tension.

Nevertheless, as pointed out by White,[2] the plate presumably aids in the radiation of the higher frequencies, particularly those from the high treble strings. Plates have been made of aluminum for lightness, but it may be that such a plate has to be reinforced with steel in order to obtain proper radiation of the higher frequencies. Cast-iron, although heavy, seems to be about the best material available for plates, and only skilled foundry men are able to handle such grey-iron castings.

There is a further interesting point about the manner in which the plate is strung. At the front end, each string is looped around a tuning pin that is imbedded in the pin-block. But at the far end, the string loops around a hitch pin and returns as the next string of the trichord, or even the first string of the next key.

This is illustrated in *Fig.* 3. It would appear that tuning one segment of the string would alter the tuning of the other segment; i.e., that the wire would slide around the hitch pin. Such is not the case, however.

THE WOODEN CASE.—Although cast iron is very strong in compression, it cannot withstand much tensile stress, and such stress is set up in the plate if it is allowed to bend. Since the wires are strung on one side of the plate, their pull tends to bend it so as to fold it in two. It is here that the strength of the case comes into play.

The plate is securely bolted to the surrounding case, which is also braced beneath the soundboard with heavy wooden beams. In the grand piano, the curved case is made up of many plies of laminated wood, all carefully seasoned and glued together. Actually there is an inner case or rim of maple and outer rim of poplar or maple, each made separately and then glued together or glued together at once. The sound board then rests on the inner rim, to which it is glued. On a nine-foot concert grand, the outer-rim veneers are twenty feet long.

Although hide glue is still used, the new plastic resin glues are preferred, particularly for tropical regions. The only objection to the plastic glues is that they require the right temperature and humidity to set properly. In the Baldwin factory, for example, you will see special fans near the ceiling that blow in the right amount of humidified air, and electronic heating equipment has been employed to speed up the hardening process. Steinway also employs similar methods.

THE SOUNDBOARD.—This is the radiating surface. One might consider it as

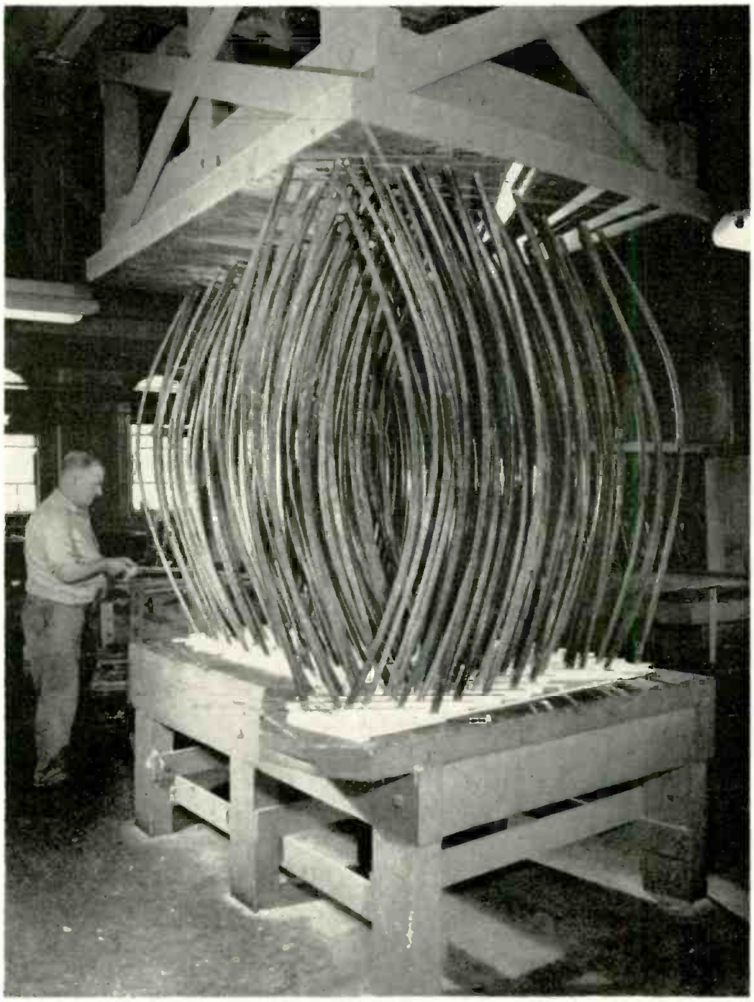

Fig. 5. Method of glueing ribs to soundboard. (Courtesy The Baldwin Piano Co.)

[2] William B. White, *"Piano Tuning and Allied Arts."*

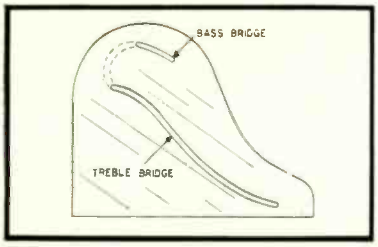

Fig. 6. Location of bridges on the sound-board.

a kind of acoustic antenna, and also as an impedance-matching device that matches the high impedance of the string to the low impedance of the air. It is often erroneously called an amplifier; it does not amplify the sound energy of the string, but merely serves as a much better radiator of sound energy than the string.

It is made of Northern Spruce, close-grained and as even in grain as possible, at least for the finer pianos. The wood is carefully dried and seasoned, and only those boards or cuttings are used that are free from knots, shakes, and so on. The individual planks are but four inches wide or so and vary in thickness from 3/8 in. at the center to perhaps 1/4 in. at the edges. They are glued edge to edge to form the large surface illustrated in *Fig.* 4.

As indicated in the figure, the grain runs diagonally to the length of the piano. At right angles to the grain are glued sugar pine ribs about an inch square in cross section. The exact acoustic function of these ribs is not clear; they may perhaps serve to convey the vibrations from one part of the soundboard to another, so as to enable the treble strings, for example, to actuate the center portion of the soundboard as well as the small area in their immediate vicinity, which action is also aided by the bridges.

However, experiments seem to indicate that the soundboard does not vibrate as a unit except perhaps for the lowest strings; instead, it vibrates in segments. More will be said about this later.

The soundboard is arched or crowned so as to press up against the strings via a bridge (to be described). It is therefore at least one function of the ribs to reinforce the soundboard and cause it to have this crowned shape.

The ribs are therefore cut somewhat arch-shaped, the soundboard is placed on a dished-out table, and the ribs placed on it, after being coated with glue. Then so-called go-bars are placed on the ribs, with their top ends pressing against the ceiling or a platform suspended from it, as shown in *Fig.* 5. As is evident from the figure, the bowed-out go-bars exert tremendous force on the ribs and soundboard, forcing it to assume the dished-out shape of the supporting table, and thus to have a crown on its under side (really the upper side when installed in the piano). (Steinway uses straight ribs, and bows them and the soundboard in the process of gluing.) This is part of the process known as "bellying," which also includes installation in the piano.

THE BRIDGES.—On top of the crowned soundboard are glued the bridges. These are made of maple, constructed variously in accordance with the individual manufacturer's experiments and conclusions. Steinway, for example, laminates their bridges so as to ensure continuity of grain from end to end. This is because the velocity of sound is from 3.2 to 12.2 times as fast along the grain as across the grain (probably the damping is much less). The idea is to make the entire soundboard respond better to a string resting at the end of the bridge.

The bridges are then capped or covered with a hard wood. Boxwood is used in the extreme treble end of the bridge, even though Baldwin points out that this wood is so expensive that it is sold by the pound rather than by the board foot. Caps on bass bridges are traditional practice; boxwood caps, especially when used on the treble bridge, represent an excellent practice. *Figure* 6 shows the shape of the two bridges and their positions on the soundboard.

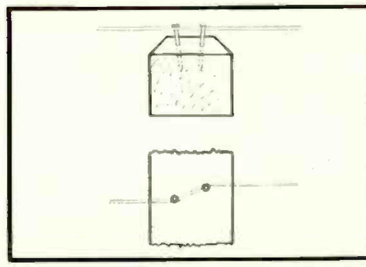

Fig. 7. Showing how a string is anchored on the bridge.

The treble strings rest on the long bridge which, owing to the crown of the soundboard, presses up against the strings, although, as we have seen previously, the plate takes up their tensile pull. (The same is true for the bass bridge.) In a grand piano the two bridges are joined as indicated by the dotted lines; this is considered somewhat preferable for tone quality. However, in the smaller pianos it is felt that the dotted-line portion would be too near the edge of the soundboard and hence would make it too stiff for proper vibration at the lower frequencies, but in some 7-foot pianos the two bridges are joined by a straight piece of maple.

Figure 7 shows how the strings are fastened to the bridge. The top surface of the latter is coated with a graphite paint, so that the strings will be able to slide along it when tuned. However, two pins—staggered as shown—serve to anchor each string to the bridge so far as up-and-down vibration is concerned. Unlike the violin, where the pressure of the string on the bridge and the little groove in the bridge are sufficient to anchor the string to it as regards lateral vibration, here the pins are used to ensure proper contact even under the most violent hammer blow, where now the vibration is in a vertical plane.

It was mentioned previously that the vibrating portions of strings, particularly of the bass strings, should be as long as possible. The bridge acts as a nodal point for the string or strings (trichord), hence it should be as far to the top end of the soundboard as possible. On the other hand, the bridge—especially the bass bridge—should act nearer the center of the soundboard, so as to actuate it where the impedance is lower and perhaps better matched to the string.

(*Continued on page 111*)

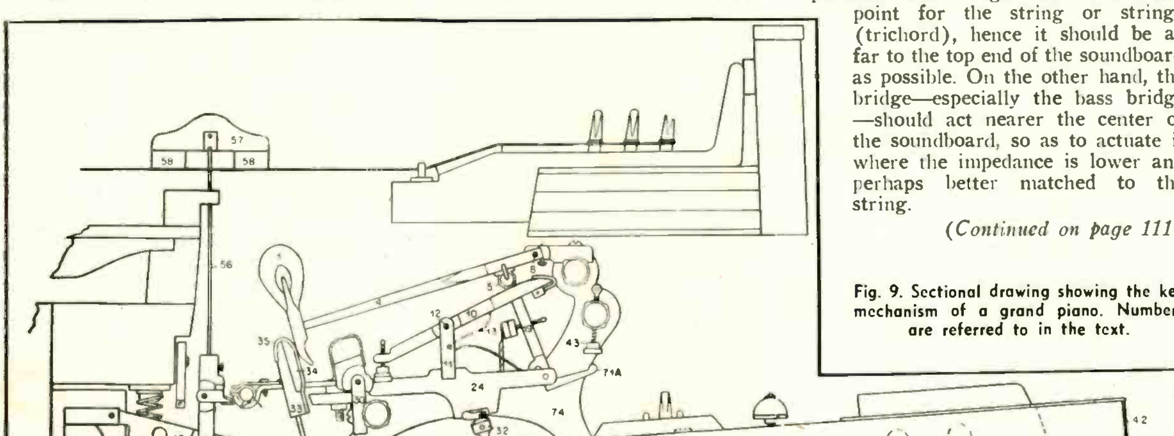

Fig. 9. Sectional drawing showing the key mechanism of a grand piano. Numbers are referred to in the text.

NEW HOME for RADIO CORP.

The "inside story" about the ultra-modern $2 million building for the world's largest electronic supply house.

ON August 10, the doors opened at 100 North Western Avenue, in Chicago, to the fabulous new home of Allied Radio Corporation—a building designed to better serve thousands of customers from all over the world who 'phone, wire, write, or just come in person, knowing that every one of the more than 20,000 items listed in the Allied catalog will be in stock for immediate delivery.

According to A. D. Davis, Allied's President, the phenomenal growth of the electronics parts industry made new and more efficient facilities necessary. In 1945, the Allied catalog listed some 8000 separate stock items—the 1954 catalog which is now being distributed lists more than 20,000. The new plant occupies 147,000 square feet of space, and provides for expansion of 80,000 square feet more when the need arises. The first floor houses the salesrooms, warehousing, shipping, and receiving sections—offices, reception rooms, and the Company's cafeteria are on the second floor. The entire building is air conditioned. Among provisions for rapid handling of orders is a five-tier conveyor system—consisting of one set of local and express belts supplying the shipping department, another set of local and express belts to the salesroom, and a return belt for empty order pans. There is also a complete system of pneumatic tubes for routing orders to the "assembly line." The building is designed to accommodate four trailer trucks at the receiving section—in a totally enclosed area so that unloading may proceed even in bad weather—and another area will accommodate four trucks at the shipping section. Over fifteen thousand linear feet of stock shelves are used for "forward" stock—that which is considered a thirty-day supply—and slightly more than that are used for "reserve" stock, a total of over six miles of shelves. The merchandise is departmentalized, with fast-moving items located near the front, and more slowly moving items progressively further back. Orders are routed through the penumatic tubes to the farthest station from which items are to be accumulated, and as these parts are placed in a fibreboard pan, they are carried to the next station by the conveyor system.

Mr. A. D. Davis, President of Allied Radio Corporation.

Each order is scheduled as to the time it should arrive at the shipping section, and when larger packages in original cartons are to be included, these are also timed to arrive at the shipping department at the same moment. Each order is checked before packing, and in most instances is on its way to the customer within two or three hours from the time it is received.

Ultra-Modern Salesrooms

Unlike the average parts distributor's showroom, Allied has installed attractive display panels to call attention to new items, to show variety of a certain class of merchandise, or to speed handling of such material as books, magazines, and other small parts. Opening off the main salesroom floor are two hi-fi studios—each equipped with Auditioners which offer immediate choice of thousands of combinations of components such as phonograph pickups, tuners, amplifiers, and speakers. Between the two studios is the hi-fi office where the customer can sit down with staff members for consultation on the selection of equipment. Another separate studio provides for "hams," and offers complete displays of receivers, transmitters, and auxiliary equipment. A "ham" station is in operation here—100 watts on phone, 150 on CW.

When the customer steps up to the counter to order a single 5Y3 or an order consisting of twenty different items, he is served promptly. For the rapidly moving tube types, a supply is available at the counter—along with numerous other popular items. When a large order is placed, the pneumatic tubes carry it out to the warehouse where it is handled just like a phoned-in or mailed-in order. As soon as the order is assembled, the customer is paged on the public address system, and so does not need to stand at the counter while his order is being filled.

The Second Floor

As one walks into the main entrance—having parked his car in the customer parking area adjacent to the door—he encounters a stairway which leads up to the reception room and the main offices—a door opens off the entrance foyer to the salesroom if he is simply interested in buying something. The reception rooms are spacious and comfortably furnished, and access to the offices is immediately behind the receptionist. Private offices line the major portion of the east side and part of the north side, with the telephone order department occupying a well lighted space to itself. Conference rooms and the cafeteria are also on this floor. To the back is the supply stockroom and the service department—the latter being separated into cubicles which are soundproofed so that two or more technicians can work at their respective tasks without interference from each other. This section of the building also provides for storage of files, and houses the air conditioning equipment, the telephone equipment room, and the telephone switchboard.

With over five hundred employees, Allied built its own cafeteria to provide clean, nourishing meals at reasonable prices—the reasonableness being attested by the availability of a complete lunch with a meat course, vegetables, coffee, and dessert at about 65 cents. Obviously, the cafeteria operates at a loss, but it is a very considerable factor in promoting good employee relations.

Allied's Famous Guarantee

Allied Radio Corporation has long been famous for its generous guarantee policy. Quoting from the catalog, the guarantee states that "Every item you buy from us must satisfy in every way—or we want you to return it at once for exchange or refund." This policy has unquestionably had much to do with Allied's success, for it is agreed that a satisfied customer is a firm's best advertisement. And it pays off, too. For example, one customer bought a medium-power transmitting tube, used it about five months (two months over the normal guarantee period for tubes) but received a replacement when he returned the tube which had obviously been worked beyond its ratings. Some years later, this same customer ordered $50,000 worth of equipment for a radio training school installation. Another customer came in with a blown fuse, received a replacement, and four months later ordered a $1200 hi-fi installation. While it is not suggested that the guarantee policy was adopted on the off chance that such windfalls might occur, it must be admitted that it appears to be an exceptionally good policy.

Close-up of the "Auditioner"—which is a playing desk with several turntables combined with switching facilities for various amplifiers, tuners, and speakers. Above the control panel is an indicator which shows the equipment in use.

Consultation by Mail

One of Allied's departments that comes in for a lot of work and occasionally an amusing inquiry is that devoted to answering customers' requests. Among interesting letters received lately has been one requesting a means for detecting poisonous paint used on roads and highways because the writer suggested this means was being used in a gigantic Communist plot to poison the citizens of this country. In another, a lady insisted she heard voices in her home although the police couldn't hear a sound. She wanted a recorder sensitive enough to record those mysterious voices so she could prove to the police that they were actually there.

Even the order department comes in for its share of surprises. During the war years, large numbers of orders were coming in from an unknown town in Tennessee. All of these orders had the highest priority ratings, occasioning some wonder as to their propriety. The government expediter following up these orders insisted that as soon as *his* project was completed, it would end the war. This aroused a considerable amount of skepticism, but the orders were filled and the shipments duly made to—as you've guessed—Oak Ridge.

The entire industry salutes Allied Radio Corporation for its foresight in providing for still greater growth in the electronics parts industry—for it is such organizations as Allied that serve as the contact between the manufacturer and the customer. The record of that service may not be engraved on marble panels, but it shows in this newest monument devoted to satisfying the electronic parts buyer.

Two views in the immense warehouse—at left, the start of the conveyor belt system; and at right, the checking and packing section at the other end of the conveyor.

On the facing page: (A) Western Avenue facade of the new building, showing some of the customer parking space. (B) On opening day, the salesroom was filled with flowers from many of Allied's suppliers. (C) Display area in sales room is open and light. (D) The City Sales counter. (E) One of the two hi-fi studios, with the second seen through the door in the background. (F) Orders assembled for the City Sales counter arrive on the conveyor. (G) Open, well lighted office space on second floor. (H) The employees' cafeteria.


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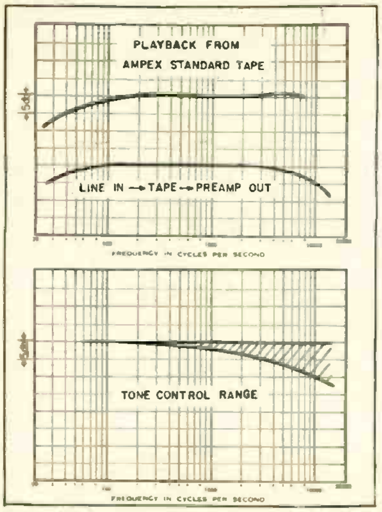
high fidelity studios



Equipment Report

TAPEMASTER HF500 TAPE RECORDER

MANY USERS of tape recorders want the equalization normally employed on only the professional types of machines, yet do not feel that their requirements warrant the usually higher cost. Among these users are those who want to exchange tapes with friends who use professional machines, and in most instances the results from the usual "home" machine are not satisfactory under these conditions.

In addition to its obvious uses in strictly professional applications, the newly announced tapeMaster HF500 is well suited to the advanced hobbyist who will be satisfied only with the professional type of equalization. Recent tests on the new machine indicate that it would be adequate for light professional requirements as well as for the advanced experimenter.

Technically, the machine offers two inputs, one for a high-impedance MICROPHONE and one for LINE—the latter being designed as a bridging input. Full modulation on the track is provided from .0008 volts at the microphone jack, or from 0.4 volts at the LINE jack. At 0 on the meter, the preamp output measures 1.6 volts, available from a cathode follower to be patched into any amplifier system. A self-contained amplifier and speaker provides for monitoring or on-the-job playback, if desired. At 100 per cent modulation, a 1000-cps tone plays back to provide an output of 0.6 volts at the preamp output. A tone control provides some high-frequency attenuation to the monitoring amplifier, but does not affect the PRE-AMP OUT jack. All connections to the recorder are made through telephone jacks. Preamp heaters are d.c. operated.

Mechanically, the machine is an improved single-speed model of the original tapeMaster. Brush Redheads give good response, and pressure pads reduce amplitude modulation to ±0.6 db at 7500 cps. Fast forward and rewind positions permit spooling in either direction in 2 minutes for a 1200-foot reel, with no tendency to spill or break tape being noted.

Performance characteristics are shown in *Fig.* 1. Using a standard Ampex tape, the measured playback characteristic is as shown, and the second curve shows the characteristic from LINE IN onto the tape, and off the tape to the PREAMP OUT jack. Measured signal to noise ratio is 45 db. The curves also show the effect of the tone control. *Figure* 3 is the complete schematic.

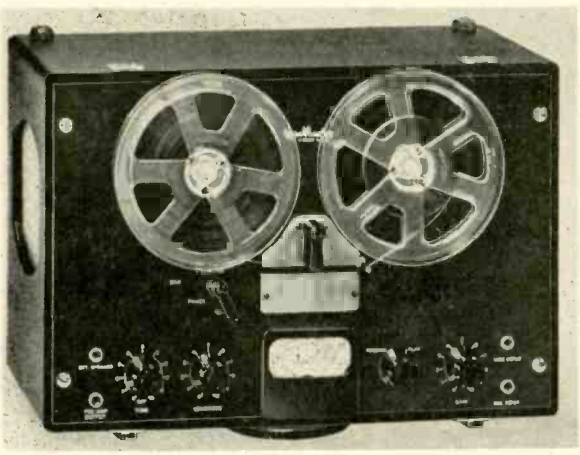
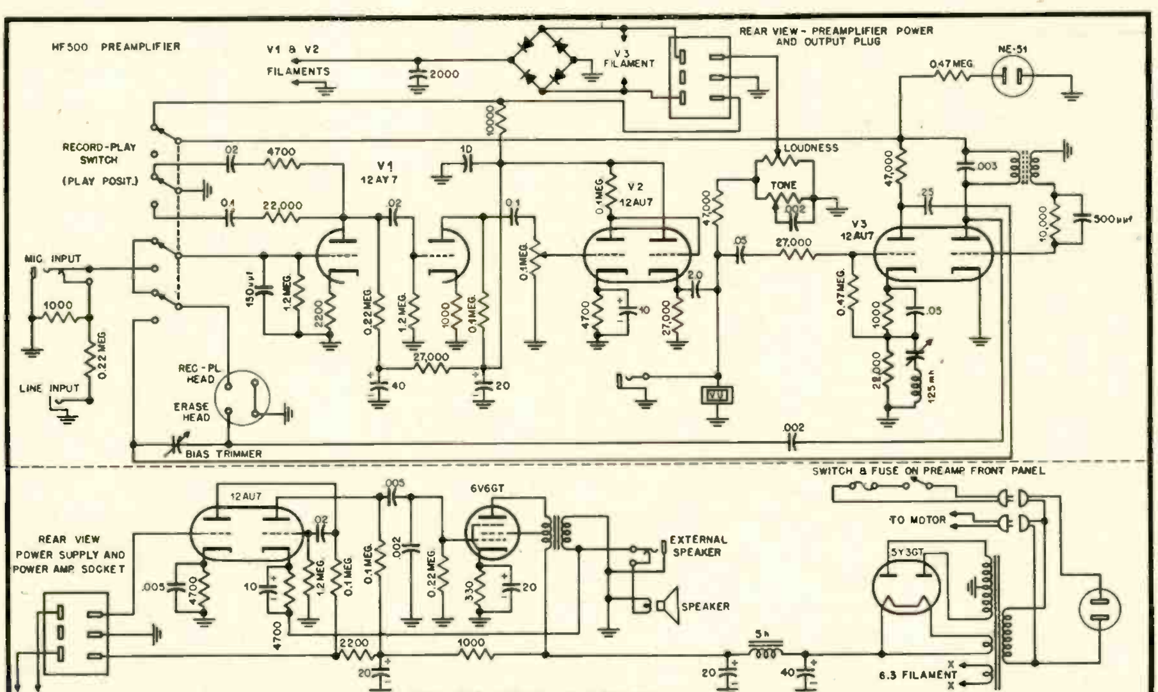
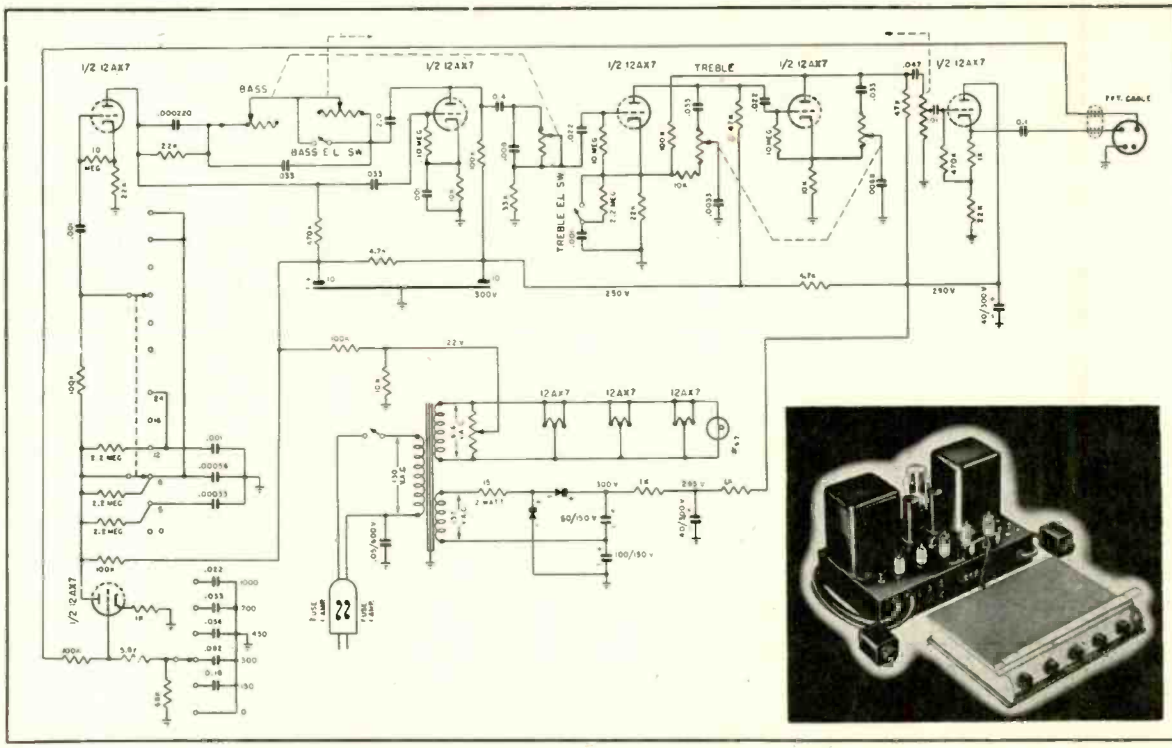


Fig. 1 (upper left). Performance curves for the HF500. Fig. 2 (left). External appearance with the cover removed. Fig. 3 (below). Over-all schematic of the new tapeMaster model.





Rauland 1826 with the Libretto

COMBINED in a system designated the 1826, the Rauland 1805 power amplifier and the Libretto remote control unit offer an unusual type of installation which would fit into the requirements of many music lovers.

The complete equipment consists of a power amplifier into which several inputs may be plugged, a separate power switch, a separate selector switch, and the Libretto —so called because of its appearance—remote unit, which is connected by a single cable to the power amplifier, of *any* desired length. The power amplifier consists of the usual four stages with feedback, together with a preamp stage and a cathode follower feeding the line to the control unit. Magnetic pickups and other inputs are plugged into this unit—the former being amplified before passing to the switch which selects the input to be fed to the Libretto. Once this selection is made, the remainder of the control is furnished by the Libretto, which is a leatherette-covered "book" with a gold-finished backbone which lifts on piano hinges to expose the controls, which are: crossover, roll-off, volume, bass, and treble. The Libretto is self-powered, and the power switch is combined with the volume control. A pair of slide switches on the bottom of the unit permit selection of loudness compensation on bass and treble ends of the spectrum independently.

While it might appear that the absence of a selector switch on the control unit would be a disadvantage, it is actually not. When changing from one source to another, it is necessary to go to the radio tuner, the phonograph turntable, or whatever sound source is being used, and while at that point the listener will adjust the selector switch. After so doing, he has all other controls at his fingertips in the remote unit.

The Libretto circuit, shown in *Fig.* 4, is unusual in that it provides for phonograph-type equalization for all program sources, thus giving the listener considerable flexibility of control—undoubtedly more than he would ever require for radio, TV, or tape sources. However, there is no harm in having the added flexibility, and many users would welcome it. *Figure* 5 shows the complete system. The Libretto is provided with two escutcheon panels so it may be used in a flat position on a table, or placed upright, as in a bookshelf. This remote unit is also available separately and, with an adapter unit, may be used with any power amplifier to provide the remote control facility. The adapter consists of the preamp and cathode-follower stages—similar to those in the power amplifier—together with a small power supply, and two switches for power and input selector. As with the 1805, these switches are attached by 5-foot cords to the main chassis.

Performance curves for the system are shown in *Fig.* 6. Intermodulation distortion was measured with two frequencies—60 and 7000 cps with a level difference of 12 db —and it will be noted that it was necessary to double back with the curve. The relatively high power output is undoubtedly due largely to the high plate voltage (515) and the use of fixed bias on the output stage. Screens operate at 460 volts. Equalization is shown for the five crossover positions and for the five roll-off positions, in addition to the flat positions on both controls. Tone control range is also shown, and Table I gives the input voltages for crystal and the two auxiliary inputs as well as for the magnetic pickup input.

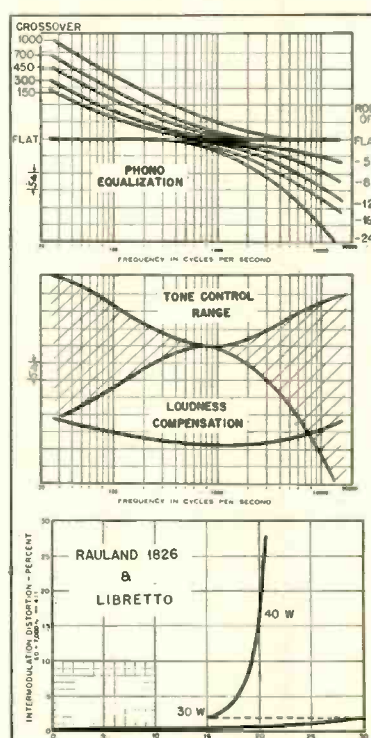
TABLE 1

Signal input voltages for 1-watt output

(Volume control maximum, controls flat)

XTAL and AUX inputs	.048 volts
MAG PICKUP input	.0025 volts

Fig. 4. Schematic of the Libretto remote control unit. Fig. 5 (inset). The complete Rauland 1826 system. Fig. 6 (below). Performance curves for the power amplifier with the control unit.



The Columbia XD (Extra Dimensional) Sound System

PETER C. GOLDMARK*

A simple means for providing a pseudo-stereophonic effect by using a small loudspeaker for the highs radiating at a point removed from the main loudspeakers in which the frequency range is restricted to the lows.

After the LP records were launched and well underway, the Laboratories' attention was turned toward investigations in the field of spatial sound. I am using the expression "spatial" in order to differentiate between the effect created by sound radiated from a hole in the wall (or a cabinet) and sound reaching the listener from different directions approaching life-like reproduction. The former has been the standard way of listening and emphasizes the synthetic nature of present-day music rendition through the conventional phonograph or radio.

Keeping in mind that reality is the most important ingredient of any reproducing medium catering to one's senses, we felt that to add to sound a new dimension, rather than just another octave or two, was our most urgent step. In the case of the phonograph and the radio, the desired effect had to be created at a low cost, at the same time using existing records and broadcasts.

There are two expressions which one hears frequently in connection with spatial sound: One is binaural and the other is stereophonic. The first one involves the listening to a program through earphones; the binaural effect depends upon the selective perception by one's ears of different signals picked up by two suitably located microphones and recorded or broadcast on two channels. There is no question about the life-like reproduction of the original sound properly distributed in space.

* *Vice-President in Charge of CBS Laboratories Division, New York, N. Y.*

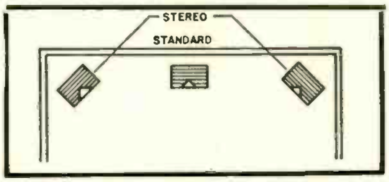


Fig. 1. Arrangement of speakers to determine listener preference for various systems.

But people today are used to listening to sound through loudspeakers, which brings up the other form of spatial sound rendition; namely, the stereophonic technique. Again, the original signal is picked up by two or more microphones transmitted or recorded on a corresponding number of channels, but the sound is reproduced through two or more loudspeakers suitably located in a room. This is where the trouble begins.

To obtain the same natural sound effect as in binaural sound, it would be necessary that the loudspeaker on the right (if two are used) be heard only by the right ear and the one on the left by the left ear. The use of polaroid glasses in three-dimensional movies is the visual analogy; unfortunately, such exclusiveness has not yet been achieved and the sound from the right speaker could readily penetrate the left ear and vice versa. As a result, much of the binaurality is lost, and the listener hears reproduction through two loudspeakers.

When demonstrating stereophonic sound using two loudspeakers placed in adjacent corners of a room, only a diluted effect results which is confined to a very limited area of the room, chiefly along an axis half way between the two speakers. Even then, a non-stationery sound source, such as a singer or actor moving about, or a speeding locomotive, is needed to give a convincing demonstration. This does not, however, represent practical conditions, since most people listen to music which is static; that is, the performers stay in one place.

In the course of our three-dimensional sound research, several of the recording sessions of Columbia Records were picked up by two properly located microphones and the respective sounds were simultaneously recorded on two tracks. This provided suitable material for binaural and stereophonic sound experiments and also permitted the study of systems which would simulate stereophonic reproduction, combining both tracks into a single one.

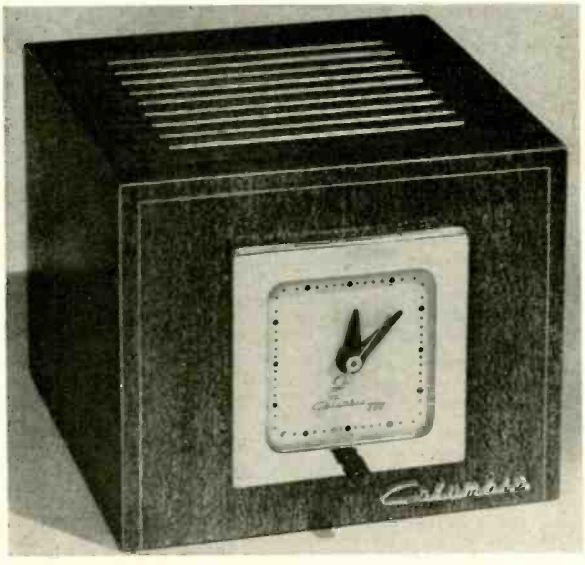
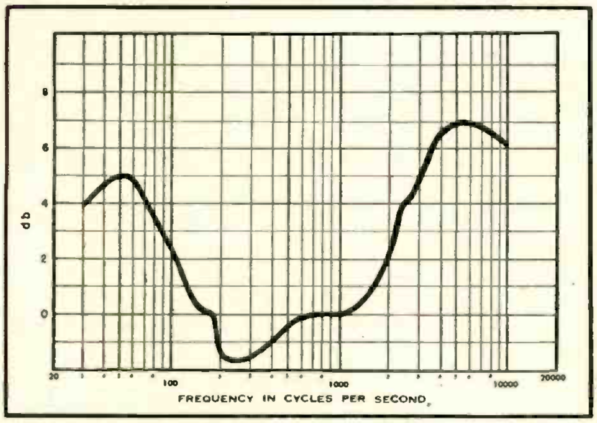


Fig. 2. The Columbia "XD" remote speaker, combined with an electric clock.

Experimental Background

During this research program, a number of basic experiments were performed and the most decisive ones will be discussed. Several selections from the stereophonic recording sessions were spliced together to form a suitable demonstration tape. Played back binaurally—that is, with headphones—the tape proved to give a very clear three-dimensional effect.

Next, a listening room was equipped with two high-quality loudspeakers placed in adjacent corners facing the listeners. A third speaker was placed in the center of one wall, half way between



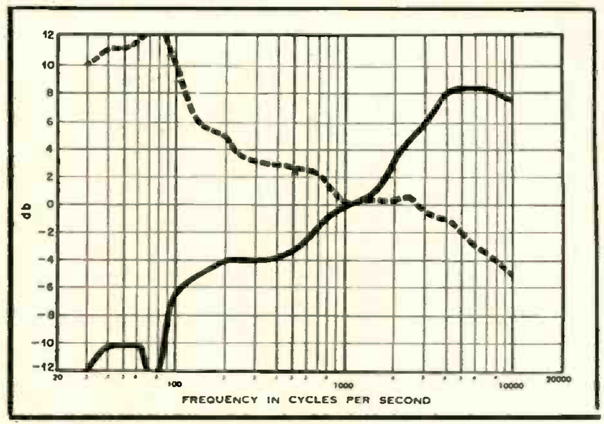


Fig. 4 (left). Amplitude characteristic of the "360" in normal use without the XD speaker plugged in. Fig. 5 (right). Responses of the "360" and the XD when the latter is plugged in.

the two corner speakers, as in *Fig.* 1. In addition, a switching arrangement was provided whereby the dual program tracks could be reproduced under three different conditions as follows:

Condition 1. The two tracks corresponding to the left and right microphones were electrically combined and fed directly to the center speaker. This was equivalent to conventional single speaker sound reproduction.

Condition 2. The left sound track was fed to the speaker in the left corner and the right track to the speaker in the right corner. This system corresponded to true stereophonic reproduction.

Condition 3. The two tracks were again electrically combined as under Condition 1, but before the resultant signal reached the left speaker, it passed through an equalizing circuit which attenuated the lows and emphasized the high frequencies. The right speaker also received the combined signal, but through an equalizer which attenuated the highs and emphasized the lows. (The specific curves will be discussed later.)

Listeners were invited to these tests without being told what the conditions were. They were asked to express their preferences of sound reproduction by choosing from any one of the three conditions outlined above. The result of the study was startling but in some respects not unexpected. While not a single listener (about a total of fifty were exposed) preferred Condition 1—that is, the single conventional speaker—their preferences were almost equally divided between Conditions 2 and 3. Evidently, the simulated stereophonic sound seemed to give as much satisfaction as the true one. As a matter of fact, when people began to wander around the room, more listeners preferred the simulated stereophonic rendition (Condition 3) because it seemed to give satisfactory results over a less restricted area than the true stereophonic sound.

A variation of these tests was performed on a number of listeners who were technically or musically well informed on the state of the stereophonic art. These listeners were told what the three conditions corresponded to and were asked to determine which Condition, 2 or 3, represented the true stereophonic rendition. Half of them guessed right and half of them guessed wrong, again proving that true stereophonic rendition can be successfully simulated with a single source of program.

It should be pointed out that a series

(*Continued on page 115*)

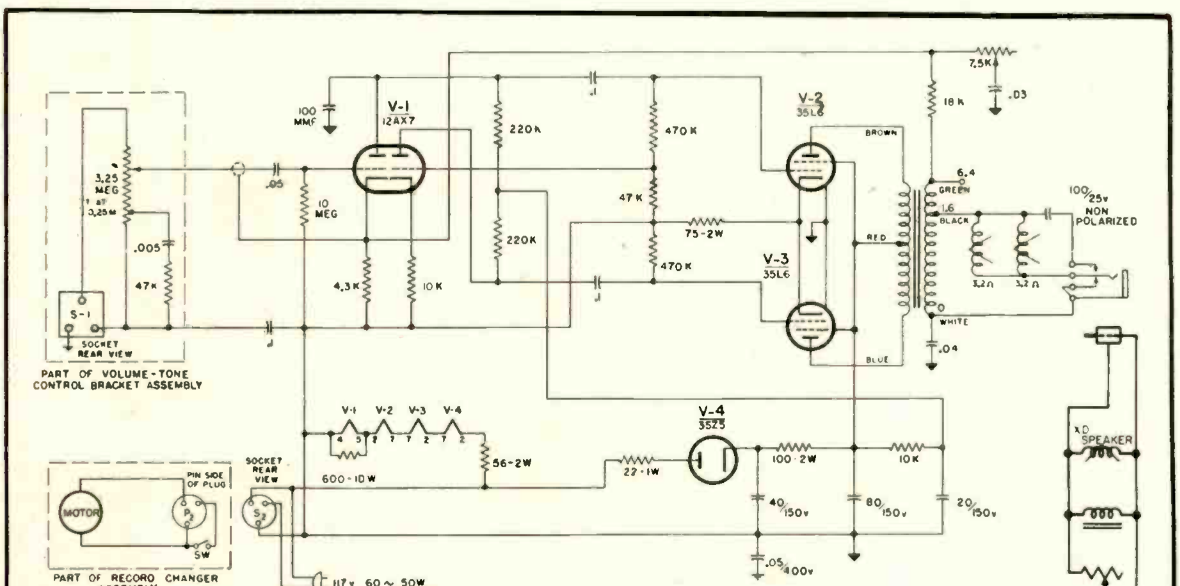
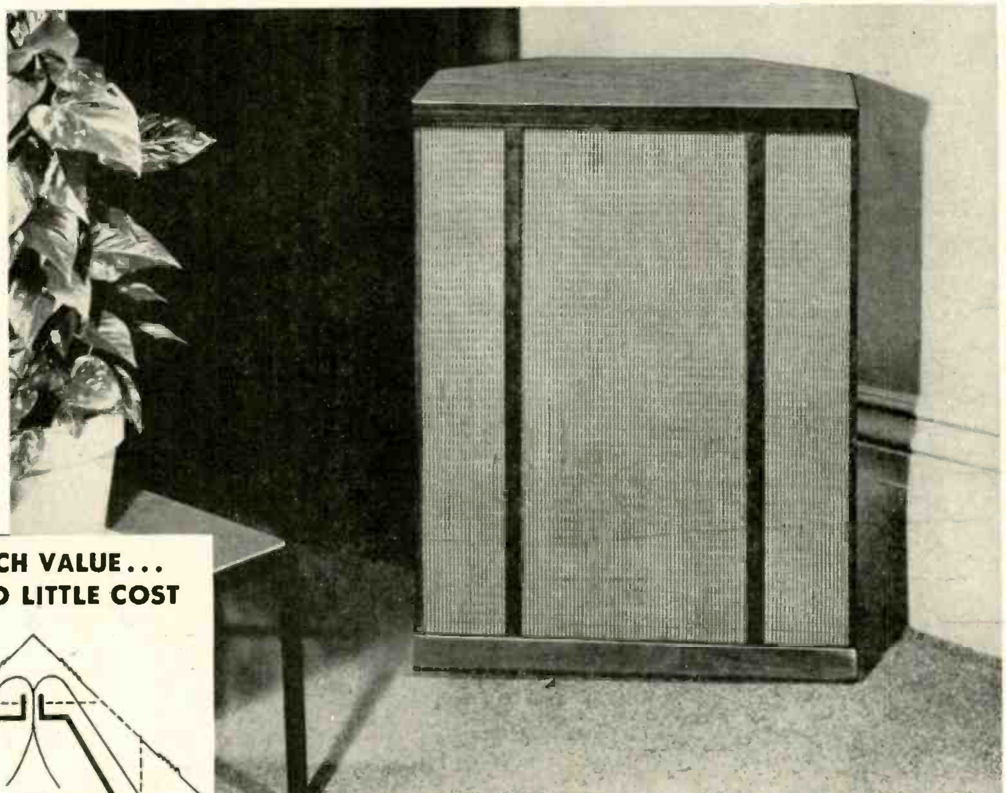


Fig. 3. Over-all schematic of the Columbia "360" and the "XD" to show circuit arrangement and switching.

paul klipsch-designed



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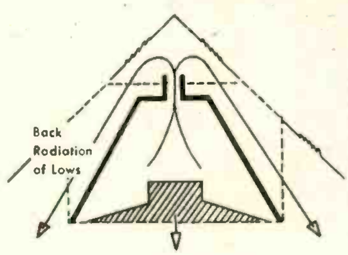
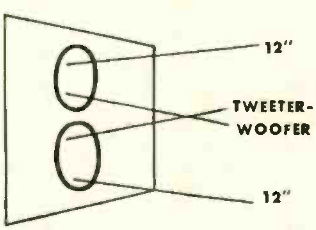


- Large enclosure performance within minimum area achieved through principle of "backloading", which increases path length and provides better reproduction of lows.
- Direct radiation of high frequencies cuts out "Masking".



- Two-way system performance. So flexible in design so as to provide you wide latitude in determining your listening requirements. Removable panel allows for a variety of speaker combinations. For example, in the 12" Klipsch you can install a single 12", two 12" speakers or a tweeter-woofer combination.

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Everyman's Amplifier

New Low-Cost Ten-Watt Unit Described as the "Ford" of the Hi-Fi Industry.

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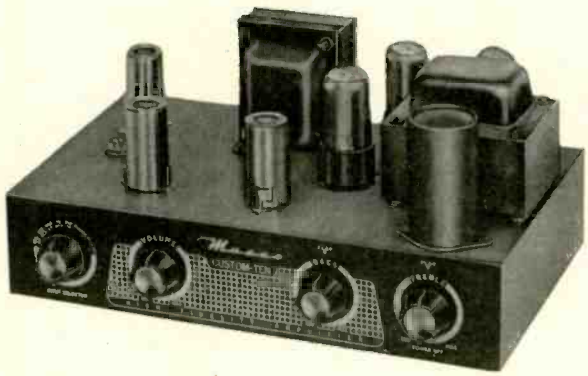


Fig. 1. The Masco "Custom Ten" amplifier, finished in black and gold.

THE NEEDS AND DESIRES of the consumer have a way of making themselves known, and as a result of information gathered through painstaking and intensive market research we have developed what is intended to be the "Ford" of hi-fi amplifiers—the answer to this need for a really good ten-watt hi-fi amplifier at reasonable cost.

The Masco Custom Ten amplifier, *Fig.* 1, provides features usually found only in the more expensive and higher-powered units. It was designed, however, to sell in the popular price range. Advanced design, unusual features, a high degree of flexibility, above-average performance, and highly decorative styling were combined to provide the unit so urgently needed by the hi-fi enthusiast with a limited (or for that matter, unlimited) budget.

* *Mark Simpson Mfg. Co., Inc., 32–28 49th Street, Long Island City 3, N. Y.*

Features

The following features and facilities were all felt to be highly desirable:

1. *Eight-Position Selector Switch,* providing choice of any one of three high-impedance, high-level program sources (such as radio tuner, TV tuner, crystal or ceramic phone pickup, or the outputs of tape, disc, or wire recorders).

The other five positions of the selector switch work with the magnetic phono pickup input to provide correct equalization for every type of record or tape recording—including the *New Orthophonic* recording curve used by RCA and recently described in the literature[1,2] and which is likely to become the industry's standard recording characteristic.

The five equalizations,[1,2,3] provided are labelled "Columbia LP," "Ortho-RCA," "NAB-LP," "78 rpm," "European 78's."

2. *Compensating Slide Switch* to permit accommodation of either high output magnetic cartridges such as Pickering or Clarkstan, or low output pickups such as GE or Audak.

3. *A Special Recorder Output,* which makes available approximately two volts of audio to permit making a tape, disc, or wire recording at the same time that the program is being heard through the amplifier system. The recorder may remain permanently connected to this jack.

4. *Bass- and Treble-Compensated Volume*

(*Continued on page 98*)

[1] EDITOR'S REPORT, AUDIO ENGINEERING, July 1953.

[2] R. C. Moyer, "Evolution of a recording curve," AUDIO ENGINEERING, July 1953.

[3] G. Leonard Werner and Henry Berlin, "New medium-cost amplifier of unusual performance." AUDIO ENGINEERING, Nov. 1952.

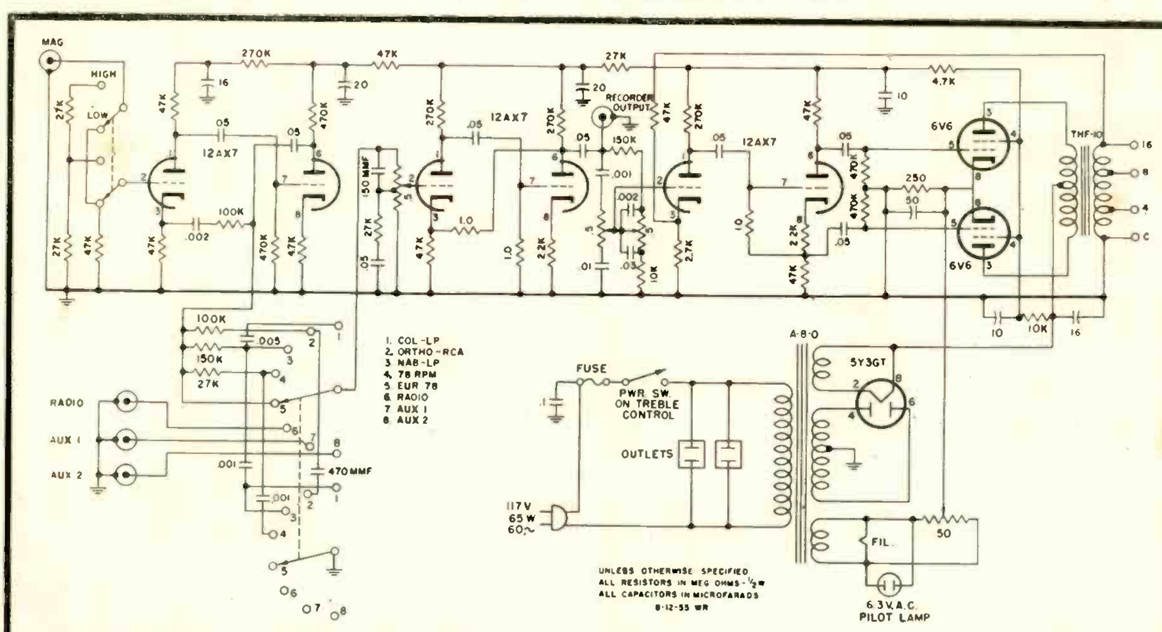


Fig. 3. Schematic of the "Custom Ten" amplifier.

Handbook of Sound Reproduction

EDGAR M. VILLCHUR*

Chapter 13. Voltage Amplifiers and Phase Splitters

A discussion of tube and circuit characteristics and their effect on frequency response and distortion in the low-level stages of audio amplifiers. Circuit configurations for phase splitters are shown and described.

THE VOLTAGE GAIN of an amplifier stage is defined as the output signal voltage divided by the input signal voltage. If vacuum tubes had no internal resistance this gain would be equal to the amplification factor (referred to by the symbol μ) of the tube. We have seen, however, that the open circuit output voltage of any practical generator is not applied directly to the load, but to a voltage divider made up of the internal resistance of the generator and the load resistance in series. The voltage gain of a stage of amplification must therefore always be less than the μ of the tube, in an amount determined by the ratio of the load resistance to the internal plate resistance. The greater the relative value of the load, the more closely the value of the gain can approach μ.

Equivalent Circuits

Amplifier analysis is facilitated by the use of a.c. equivalent circuits, from which characteristics such as gain, effective internal impedance, and frequency response can be readily derived. *Figure* 13—1 illustrates a typical stage of voltage amplification, and equivalent plate circuits. An a.c. generator, with an open-circuit output voltage equal to μE_g (the input signal multiplied by the amplification factor) is substituted for the tube and the associated circuit elements that are required to make the tube work. All elements that are not in the signal circuit are eliminated; thus the B supply and the cathode resistor, which when properly bypassed present negligible resistance to the signal, do not appear in the diagram. The plate resistance of the tube, R_p, and the external load presented to the tube make up the total load seen by the generator. In C of *Fig.* 13—1 the effects of the coupling capacitor and of the input capacitance to the following stage are assumed negligible at signal frequencies; the single load R_L represents the plate resistor and the following grid resistor in parallel, that is, $R_l R_g/(R_l + R_g)$.

* *Contributing Editor,* AUDIO ENGINEERING.

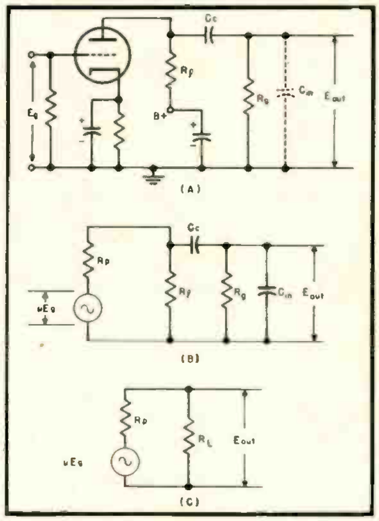


Fig. 13—1. (A) Voltage amplifier stage. C_{in} is the effective input capacitance to the following stage. (B) Equivalent a.c. circuit. (C) Simplified equivalent a.c. circuit, assuming C_c shorted and C_{in} negligible at signal frequencies. R_L is the parallel combination of R_l and R_g

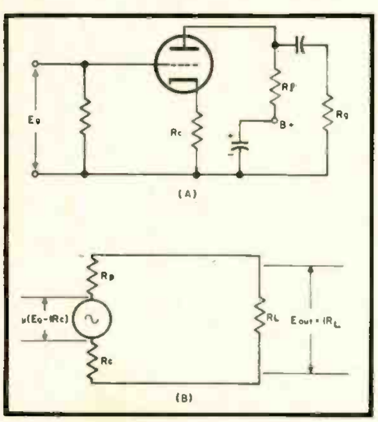


Fig. 13—2. (A) Voltage amplifier with negative current feedback secured from unbypassed cathode resistor. (B) Equivalent a.c. circuit.

It can be seen by inspection of C in *Fig.* 13—1 that the output voltage appearing across R_L will be equal to:

$$E_{out} = \mu E_g \times \frac{R}{R_L + R_p}$$

The voltage gain is thus equal to:

$$\frac{E_{out}}{E_g} = \frac{\mu R_L}{R_L + R_p}$$

The same expression for gain may also be derived by applying Ohm's law, calculating the signal current from the applied voltage and total load, then calculating the IR drop across R_L. The current thus derived represents only the a.c. component of the plate current, and has nothing to do with the actual number of d.c. milliamperes flowing in the tube.

The Ohm's law derivation of the gain equation for a stage with an unbypassed cathode resistor R_c, (see *Fig.* 13—2), is shown below for the purpose of familiarizing the reader with the construction and use of equivalent circuits. In this case the original input voltage E_g is reduced by IR_c, the signal voltage drop across the cathode resistor. It must be remembered that the d.c. component of the tube current is neglected.

$$\text{Voltage gain} = \frac{E_{out}}{E_{in}} = \frac{IR_L}{E_g}$$

$$I = \frac{E_{generator}}{R_{total}} = \frac{\mu(E_g - IR_c)}{R_L + R_p + R_c}$$

$$\mu(E_g - IR_c) = (R_L + R_p + R_c)I$$

$$\frac{\mu E_g}{I} = R_L + R_p + R_c + \mu R_c$$

$$I = \frac{\mu E_g}{R_L + R_p + R_c(\mu + 1)}$$

$$\text{Voltage Gain (with negative current feedback)} = \frac{\mu R_L}{R_L + R_p + R_c(\mu + 1)}$$

To calculate the source impedance seen by the load, a generator of arbitrary voltage E is substituted for the load impedance, and the generator representing the tube is short-circuited, indicating zero input signal. Any feedback voltages are represented by series generators with a polarity appropriately related to that of the load generator; thus a generator representing a negative current feedback voltage will have a polarity opposite to that of the load generator, (see *Fig.* 13—3) while negative voltage feedback will be represented by a generator with the same polarity as the load generator. The

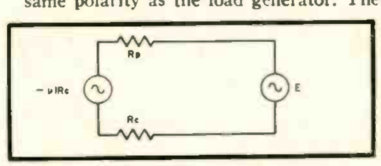


Fig. 13—3. Equivalent a.c. circuit to stage with unbypassed cathode resistor, constructed for purpose of calculating effective internal impedance. This is the impedance seen by a generator, of arbitrary voltage E, which has been substituted for the load.

derivation given here, referred to in *Fig.* 13—3, is for negative current feedback; the reader may wish to check the equations for source impedance with negative voltage feedback, positive current feedback, etc.

$$\text{Source Impedance } (R_{int}) = \frac{E}{I}$$

$$I = \frac{E_{total}}{R_{total}} = \frac{E - \mu I R_c}{R_p + R_c}$$

$$I\,(R_p + R_c) = E - \mu I R_c$$

$$R_p + R_c = \frac{E}{I} - \mu R_c = R_{int} - \mu R_c$$

$$R_{int} = R_p + R_c + \mu R_c = R_p + R_c\,(\mu + 1)$$

For a multistage feedback loop μ becomes the gain with the final load open, R_c the resistor in series with the load.

Frequency Response

At low frequencies the coupling capacitor C_c of (B) in *Fig.* 13—1, and the grid resistor R_g, form a voltage divider that reduces the input signal to the following stage. When the frequency becomes low enough so that the reactance of C_c is numerically equal to the resistance of R_g the signal voltage across R_g will be reduced, by approximately 3 db, from the total signal across the voltage divider. (The value of the total load presented to the previous stage will also be increased somewhat.)

Although it might be expected that when the reactance of C_c is equal to R_g the signal voltage will be halved, and the reduction amount to 6 db, it must be remembered that the reactance of C_c is a vector quantity.

The low-frequency amplification of a stage may be expressed as a fraction of the mid-frequency gain:

$$A_L = \frac{A_M}{\sqrt{1 + \dfrac{1}{(\omega R_1 C_c)^2}}}$$

where A_L = Low-frequency gain (does not include phase shift)
A_M = Mid-frequency gain
$\omega = 2\pi \times$ frequency concerned
$R_1 = R_g + \dfrac{R_l R_p}{R_l + R_p}$
R_p = tube plate resistance; R_l = plate resistor; R_g = grid resistor
C_c = Capacitance of coupling capacitor, in farads

Figure 13—4 plots the low-frequency transmission of amplifier networks with given coupling capacitors and grid resistors. It should be evident that the lower the value of the grid resistor the greater must be the value of the coupling capacitor for the same low-frequency transmission.

The low-frequency response of an amplifier may also be reduced by insufficiently large cathode and screen bypass capacitors. If the reactance of the cathode bypass at low frequencies becomes appreciable, relative to the bias resistor, discriminative negative current feedback and bass attenuation are introduced. If the capacitor bypassing the screen to ground is too small to be effective at low frequencies, signal voltage variations appear on the screen grid, of such polarity as to reduce the cathode-plate signal current and cause the signal frequencies concerned to be attenuated.

Simplified expressions[1] for calculating approximate required minimum capacitances in audio applications (not considering phase shift) appear below:

$$C_c = \frac{1.6 \times 10^6}{f_L R_g}\ \mu f$$

$$C_k = \frac{1.6 \times 10^6}{f_L R_c}\ \mu f$$

$$C_s = \frac{1.6 \times 10^6}{f_L R_s}\ \mu f$$

where C_c = Coupling capacitor
C_k = Cathode bypass capacitor
C_s = Screen bypass capacitor
f_L = Low-frequency limit in cps
R_g = Grid resistor, ohms
R_c = Cathode resistor, ohms
R_s = Screen dropping resistor, ohms

The treble response of an amplifier stage is limited by the shunt effect of the tube capacitances, illustrated in *Fig.* 13—5. The effective input capacitance of a stage is not merely the sum of the inter-electrode tube capacitances, but is affected by the amplification of the tube:

[1] Charles P. Boegli, "A note on volume controls," AUDIO ENGINEERING, p. 40, April, 1953.

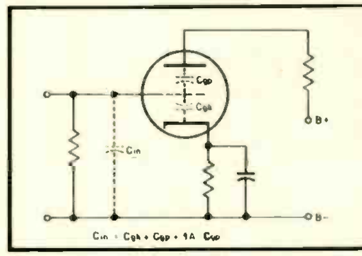


Fig. 13—5. Inter-electrode tube capacitances, whose combined effect is represented by C_{in}, the input capacitance of the stage.

$$C_{in} = C_{gk} + C_{gp} + |A|\, C_{gp}$$

where C_{in} = Effective input capacitance of tube
C_{gk} = Grid-cathode inter-electrode capacitance
C_{gp} = Grid-plate inter-electrode capacitance
$|A|$ = Absolute value of voltage gain

The effective tube capacitance forms a shunt across the lower arm of the plate resistance-load voltage divider. (The lower arm is the parallel combination of R_l and R_g. When the resistance of the combination of R_l and R_g is very large the shunt capacitance has an appreciable effect on the value of the total load impedance at high frequencies, but when the resistance of the combination is low the further shunt reactance changes the total load value very little. The effect of the change in load value is reduced by a low plate resistance that causes the stage to approach constant-voltage operation. Thus, high-frequency response is aided by low values of plate and grid resistors, by low tube amplification and plate resistance, and by low inter-electrode capacitance, especially that between control grid and plate. With normal R-C coupled circuits the upper frequency limit is well above the audio range.

The high-frequency amplification of a stage is equal to:

$$A_H = \frac{A}{\sqrt{1 + (\omega R_e C_{in})^2}}$$

where A_H = High-frequency gain (does not include phase shift)
A_M = Mid-frequency gain
$\omega = 2\pi$ times the frequency concerned
R_e = The parallel combination of R_p, R_l and R_g
$= \dfrac{R_p R_l R_g}{R_p R_l + R_p R_g + R_l R_g}$
R_p = tube plate resistance; R_l = plate resistor; R_g = grid resistor
C_{in} = Effective input capacitance, in farads.

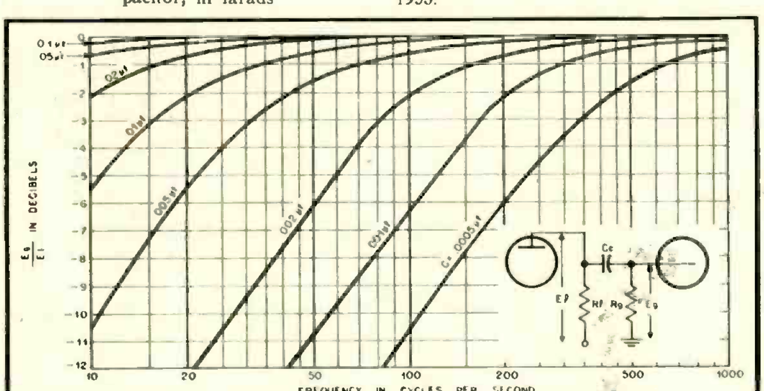


Fig. 13—4. Approximate low-frequency transmission of R-C coupling networks into grid resistor of 1.0 megohm (assuming R_p and R_l of first stage small). For other values of grid resistor multiply C by 1.0 meg/R'_g. To include effect of R_p and R_l, use $R_g + R_l R_p/(R_l + R_p)$ for R_g. *(After F. Langford Smith)*

The insertion of a series element between stages, such as the upper arm of a potentiometer used as a volume or tone control, adds to the effective value of the source impedance seen by the input terminals of the following stage, and therefore reduces the high-frequency range for the same circuit values (counting the effect of the reduced resistance of the

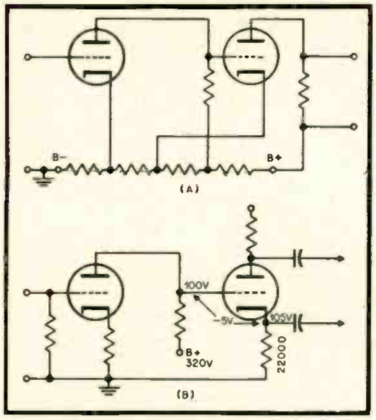


Fig. 13—7. (A) Direct-coupled amplifier using tapped B supply. (B) Direct-coupled circuit used in Williamson amplifier. The 100 volts (relative to ground) on the grid is offset by the 105 volts between cathode and ground.

lower arm of the volume control).[2] The restriction, however, is generally from one ultrasonic value to a lower one, and therefore not significant; controls can never be included within a feedback loop where ultrasonic response may be needed. One circuit position where the effect of the control on high frequencies may be important, however, is the input to a long cable.

[2] Technical Manual—Sylvania Radio Tubes, Sylvania Electric Products, Inc., Emporium, Penna., 1946, p. 32.

From the above it may be seen that the frequency range of a resistance-capacitance coupled stage can within limits be chosen at will, and is not ordinarily dependent upon any subtle virtues or defects of the circuit components.

Distortion in Voltage Amplifiers

Voltage amplifiers are, under normal circumstances, operated in class A_1. As in the case of power amplifiers the percentage of distortion is a function of the signal amplitude; the voltage amplifier stages that are most subject to distorting influences are therefore the "high-level" stages just prior to the power amplifier. The same methods that are used to decrease distortion in the power amplifier may be used here—the application of inverse feedback (both voltage and current feedback are equally beneficial) and the use of push-pull circuitry.

Negative current feedback may be inserted simply by omitting the bypass capacitor from the cathode bias resistor. Harmonic distortion and other undesirable effects are reduced, as with voltage feedback, by the gain reduction factor, while the increase of source impedance is of no consequence. If the loss of gain can be afforded, the only disadvantage of an unbypassed cathode resistor lies in the increased danger of hum picked up from heater-cathode leakage.

Voltage amplifiers in push-pull exercise the same discrimination against even harmonic distortion as power amplifiers. The actual cancellation does not take place, however, until the signal passes through a common load such as the output transformer.

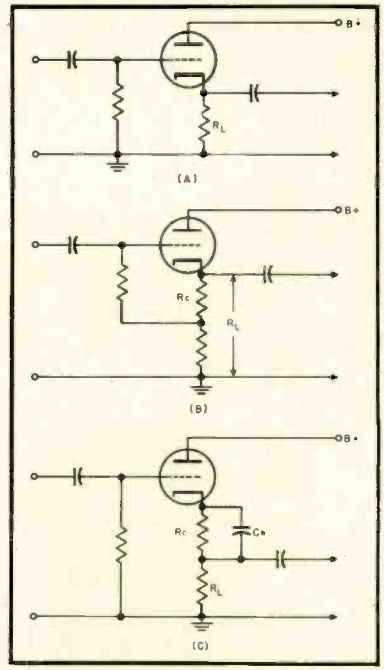


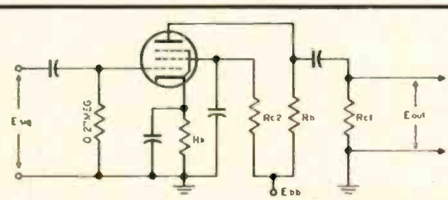
Fig. 13—8. (A) Cathode follower voltage amplifier. All of the voltage across R_L is fed back to the input, constituting 100 per cent negative voltage feedback. (B) Method of providing correct bias for cathode follower stage when R_L is too large. The bias voltage is formed across R_C. (C) Method of providing correct bias for cathode follower stage when R_L is too small. The bias voltage is formed across the series combination of R_L and R_C. If C_K is eliminated, R_C will provide negative current feedback.

Bias Voltage

Bias in a voltage amplifier is obtained from a cathode resistor in the overwhelming majority of cases. Occasionally the grid resistor method is used in low-level stages such as phonograph preamplifiers. In the latter case a grid resistor of high value, of the order of 10 megohms, is used between grid and ground, while the cathode is grounded.

The Use of Tube-Manual Data in Designing R-C Coupled Voltage Amplifiers

Although circuit equations may be used to design voltage-amplifier stages, the values of circuit elements for most of the common applications can be determined by referring to prepared charts. *Figure* 13—6 illustrates a section of such a chart, and includes a diagram of the circuit elements to which the symbols refer. The gain and distortion characteristics accompanying various combinations of circuit values, supply voltages, signal amplitude, and in some cases type of bias may be read directly. The importance of not over-driving stages located prior to the volume control (where the increased signal amplitude will not be



RESISTANCE COUPLED AMPLIFIER DATA

Self Bias Operation

6SJ7

	Ebb = 100 VOLTS							Ebb = 250 VOLTS						
Rb	0 1		0 27			0 47		0 1		0 27			0 47	
Rc2	0 39		1 2			1 8		0 39		1 2			2 2	
Rc1	0 27	0 47	0 27	0 47	1 0	0 47	1 0	0 27	0 47	0 27	0 47	1 0	0 47	1 0
Rk	1200	1200	2700	2700	2700	4700	4700	560	560	1200	1200	1200	1800	1800
Ib	0 645	0 645	0 259	0 259	0 259	0 165	0 165	1 77	1 77	0 675	0 675	0 675	0 402	0 402
Ic2	0 18	0 18	0 068	0 068	0 068	0 045	0 045	0 50	0 50	0 183	0 183	0 183	0 102	0 102
Ec1	0 99	-0 99	0 882	-0 882	-0 882	-0 99	-0 99	-1 27	-1 27	-1 03	-1 03	-1 03	-0 908	-0 908
Ec2	29 8	29 8	18 5	18 5	18 5	19 0	19 0	55	55	30 5	30 5	30 5	25 5	25 5
Eb	35 5	35 5	30 2	30 2	30 2	22 5	22 5	73	73	67 8	67 8	67 8	61 2	61 2
Esig	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1	0 1
Eout	6 85	7 8	8 2	10 2	12 5	10 2	13 1	10 2	11 5	13 6	17 9	21 6	19 5	25 6
Gain	68 5	78 0	82	102	125	102	131	102	115	136	179	216	195	256
% Distortion	0 6	0 7	3 4	2 6	2 1	2 8	1 2	0 7	0 8	2 2	1 8	1 5	3 1	2 4
Esig(¹)	0 2	0 2	0 14	0 14	0 14	0 13	0 13	0 5	0 5	0 25	0 25	0 25	0 15	0 15
Eout	13 15	14 9	11 1	13 9	17 2	12 8	16 6	47	54	33	41 8	50	28	37
Gain	65 8	74 5	79 4	99 5	123	98 5	128	94	108	132	167 5	200	187	247
% Distortion	3 0	2 9	5 1	4 3	3 7	4 6	5 0	4 2	5 0	5 2	4 4	4 7	4 5	1 7

Note (¹) At grid current point, less than ½ microampere grid current

Fig. 13—6. Sample of R-C coupled amplifier data used for selecting circuit values. (Part of a chart from the Sylvania Tube Manual)

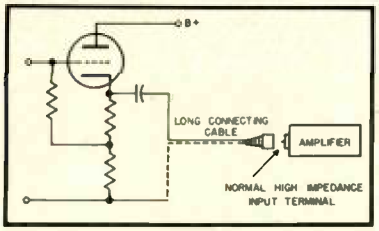


Fig. 13—9. Use of a cathode follower for overcoming effects of long connecting cable on high-frequency response and hum level. Common value for cathode load is 10,000 ohms.

evident in the final output) and of choosing tubes and circuits adequate to handle the signal voltages that will be fed to them, is apparent from the distortion data. Since negative feedback reduces only gain and not the output capabilities of the stage, the allowable input signal is increased by at least the feedback gain reduction factor.

Direct-Coupled Stages

The function of the coupling capacitor is to keep d.c. from the following grid, while allowing the signal to pass. This capacitor may be eliminated, and the plate connected directly to the following grid, if the positive d.c. plate voltage applied to the grid is over-balanced, in such measure that the resultant bias voltage between grid and cathode is negative and of the proper value. (A) of *Fig.* 13—7 illustrates the principle of a direct-coupled amplifier. Although such amplifiers present stability problems much greater than occur in conventional R-C designs and need special power supplies, they are required in certain applications. The measurement of minute body potentials in medical work, for example, calls for an amplifier that responds to input voltage stimuli which may change very slowly or not at all.

Direct-coupled stages may also be incorporated in audio amplifiers for the purpose of reducing phase shift within the feedback loop. (B) of *Fig.* 13—7 illustrates the direct-coupled input stages of the Williamson circuit. The positive voltage on the second grid is more than offset by the IR drop across the large cathode load resistor, so that the final bias voltage is – 5 volts, as shown.

The Cathode-Follower Voltage Amplifier

The cathode-follower circuit mentioned in Chapter 12, various forms of which are illustrated in *Fig.* 13—8, is most commonly used in voltage applications. The voltage gain is always less than one, indicating that the stage can serve no purpose simply as a voltage amplifier, however low the distortion. Other characteristics, however, make the cathode follower an extremely useful circuit. These characteristics include:

1. Very low input capacitance—little more than the grid-plate inter-electrode capacitance of the tube—making possible use of the cathode follower as a buffer stage between a high-impedance source and a high-capacitance load.
2. Near-constant-voltage operation associated with the 100 per cent negative voltage feedback. The range of load impedance values that can be used is much greater than in conventional circuits, making it possible to match the characteristic impedance of low-impedance lines.
3. The output has one side grounded and is in phase with the input.
4. Very low distortion, wide frequency range, and low phase shift.
5. High signal-handling capability.

When a signal is applied to the grid of the cathode follower, the instantaneous voltage across the cathode load resistor adjusts itself to a value somewhat less than the signal voltage. The voltage "gain" varies from about .5 for very low values of load impedance, such as provided by low-impedance transmission lines, to about .9 for resistances of 10,000 ohms or more.

The voltage gain of a cathode follower, ignoring reactances, is equal to:

$$\frac{\mu R_L}{R_p + R_L} \times \frac{1}{1 - A\beta}$$

$$\left[\begin{array}{l} \text{where } \beta = 1 \\ A = \dfrac{-\mu R_L}{R_p + R_L} \end{array}\right]$$

$$= \frac{\mu R_L}{R_p + R_L(\mu + 1)}$$

where R_L = Cathode load resistor
R_p = Tube plate resistance

The cathode follower is useful in vacuum-tube voltmeters, where it is very important that the input impedance be very high so as not to disturb the circuit

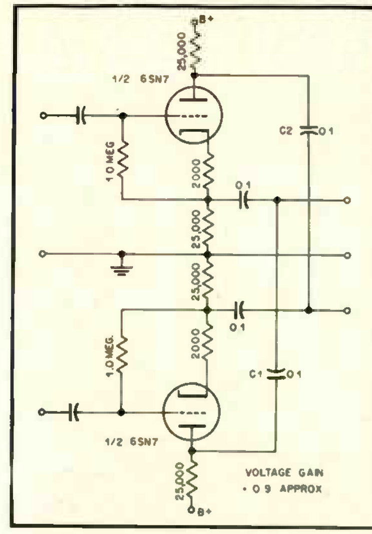


Fig. 13—11. "Phase compressor" for correcting an imperfectly balanced push-pull signal.

being measured, and in video applications. The cathode follower is also useful in audio systems as a high-quality, noncritical matching or buffer stage. A high impedance source—for example, the output of a preamplifier tube—may feed an amplifier that is located at an appreciable physical distance. The capacitance between the shield and central conductor of the cable provides an effective shunt across high-impedance circuits and attenuates the treble frequencies. In ad-

(*Continued on page 104*)

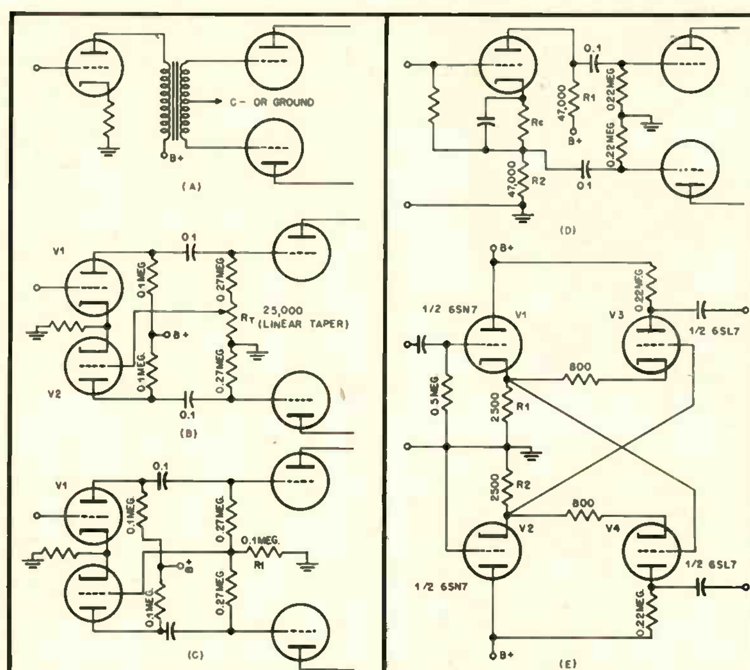
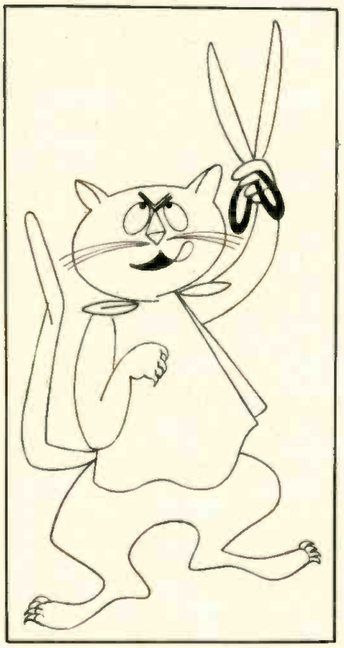


Fig. 13—10. (A) Transformer phase splitter. (B) Tapped-voltage phase splitter, with common circuit values. (C) Floating-paraphase phase splitter. (D) Split-load or cathodyne phase splitter. R_C is selected on the basis of the total load, $R_1 + R_2$. (E) Cross-coupled phase splitter.

The Great Mystery of Dannemora Dungeon

Binaural by Parable, by Golly

Most readers will have heard the term "Binaural" even though they have not yet been subjected to its advantages. The author—in the forefront of binaural development—comments interestingly in an unusual form.

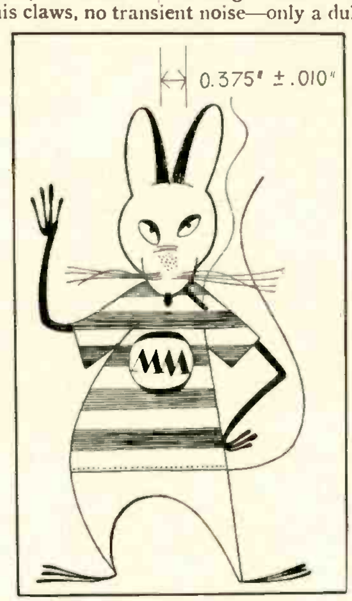


Once upon a time there was a great dungeon deep under Dannemora castle. It often had been used for the medieval purpose of corrective politics, but now it was populated only with mice—many, many mice. The dungeon was pitch black, with not a single gleam of light, and in order to survive, the mice had to perceive binaurally the direction of approach of the castle cats. Wherever the cats would go in the inky pit, the prey would have just departed, leaving the *smell* of mice, but no *edible* mice.

Above, in the castle rooms there was a remarkable cat, the pet of a noble duke and his duchess. Tommy was not like other cats, for he was the re-incarnation of Prof. Kamstak Lodov, the great Russian scientist, well-known to have discovered the principles of depth perception and stereo several centuries ago.

One day the mice in the dungeon became a problem to the noble duke, because he wished gently to incarcerate a noble enemy—gently since he well knew that possibly some day the noble enemy might instead be incarcerating *him*. So the Duke of Dannemora called to his footman, and directed that Tommy be placed in the dungeon in an unfed frame of mind. But Tommy refused at first to be led down the wet stony steps to the creaky iron dungeon door, and called first for the sharpest pair of scissors in the kingdom. When these were found and brought to him, he sat down and cut off the tips from all his claws,—an odd procedure indeed for a cat about to enter into predatory activities. But remember, Tommy was the re-incarnation of François Popov, world famous Russian binaural scientist.

Tommy then allowed himself to be led down the wet stony steps to the creaky iron door, and while in transit, please note, he made no clicking sound with his claws, no transient noise—only a dull



padding centering around 250 cps, as he had no doubt planned.

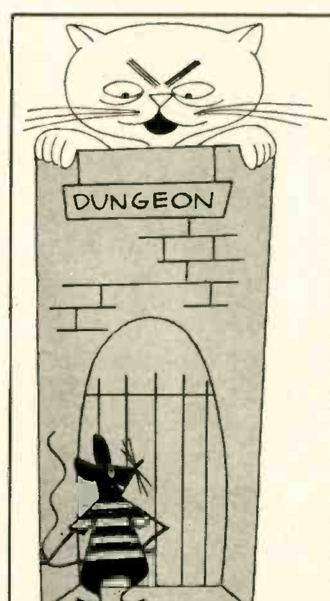
For all of three weeks and three days the great iron door was left closed and locked, but finally there came the predestined hour, and as the hinges groaned open, Tommy staggered out, replete and bursting with masticated mice, the product of 4 and 20 days of using low-pass filters. As Tommy recuperated on his pillow he began to reflect. The cloying taste of mice lingered overlong, and he yearned insatiably for other fare, even if only as a chaser. Well knowing by experience with mice that the *ability of potential prey to perceive direction of approach* depended upon keeping the sounds of his approach below 1,000 cps, he again clipped his claws to prevent the clicking, and set out across the moat on a black moonless night to find his fortune. Suddenly a strange and exciting scent was in the air, and as he followed it along well-filtered in his 250-cps way, Tommy was abruptly trampled to death by an old lady in a wheelchair with an ear-trumpet, who was binaurally astute down as low as 80 cps with a 9-inch ear spacing.

Tommy had made a miscalculation.

Tommy even today is again being reincarnated.

The Explanation (?)

Of course the answer lies in examining for the particular animal in question the range of maximum sensitivity in the audio spectrum. Bats, for instance, have maximum sensitivity in the range of 12,000 cps, because those are the frequencies for which the ear spacing is a half-wave length. The human head is inaccurately described as 6 inches and functions best at 1,000 cps. Incidentally, the voice of the specie tends to pitch it-



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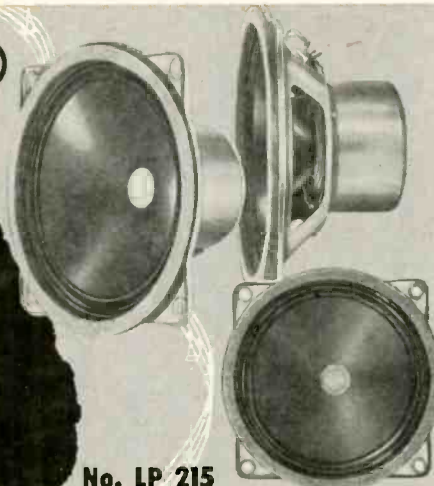

Here is "realism" in sound reproduction every music lover and sound engineer will instantly appreciate. Unusual quality LORENZ speakers plus acoustically correct KINGDOM enclosures give you real "presence" of sound at surprisingly low cost.

Now you can come closer than ever before to this

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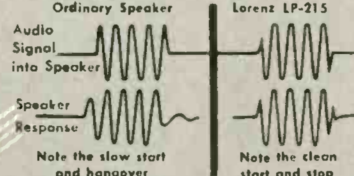
No. LP 215 "WOOFER" LOUDSPEAKER

Here is a new speaker that speaks for itself. Made by Lorenz, leading European audio manufacturer and made expressly for Kingdom Products. Lorenz experience and fine craftsmanship make these speakers exceptional in quality and value! The frame is heavy and rigid, free of burrs . . . The mounting holes are outside the cone rim circle to eliminate twisting of the cone . . . The thick felt flange (no cardboard) is provided to seal and damp out undesirable resonances which may come from the enclosure.



"Hangover" is completely eliminated. A drum roll is a drum roll — not a buzz or hum. Each staccato sound in is staccatto out. The result is clear tonal quality which can be heard with pleasure and without fatigue at any loudness level. Specifications:

- Mounting holes — 9¼″
- Frame diameter — 8½″
- Cone diameter — 7½″
- Mounting hole (enclosure) — 7½″
- Free air cone resonance — 75 cycles
- Frequency response ± 2.5 db to 13,500 cycles
- Magnet — High FLUX — Alnico 400
- Flux density in Air Gap — 9,500 gauss
- Energy in air gap — 170 milliwatts
- Power rating — 8 watts
- Optimum amplifier output impedance — 4 ohms

We are proud to bring you the Lorenz loudspeakers, and we know that you will be an equally proud owner because it will match the finest equipment used with it.

NET $22.50

NEW KINGDOM HIGH PASS FILTER

No. HP-1 — The HP-1 filter has a nominal "crossover" at 5000 cycles and is intended to increase the contribution of "highs" at a rate of 3 db per octave starting at 2000 cycles. Its effect increases smoothly with frequency so that at 12,000 cycles and up where most speakers fall off, the tweeter is in full use extending the sound output of the system to the limit of audibility. NET $4.95

NEW LORENZ TWEETER

No. LP-65 — Here is the tweeter to complement any Woofer. This high frequency speaker will carry the "highs" as you want it — Clean, Clear and Sweet.

Specifications:

- Outside diameter — 2½″ (65 mm.)
- Cone diameter — 2¼″ (57 mm.)
- Mounting hole — 2¼″ flared to 2½″ or more
- Free air cone resonance — 1,600 cycles/sec.
- Upper frequency response — ± 2 db to 14,500 cycles and down 5 db at 16,000 cycles
- Magnet — High Flux Alnico 400
- Flux density in air gap — 10,000 gauss
- Energy in air gap — 37 milliwatts
- Power rating — 2 watts max.
- Voice Coil Impedance — 5.5 ohms

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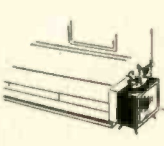
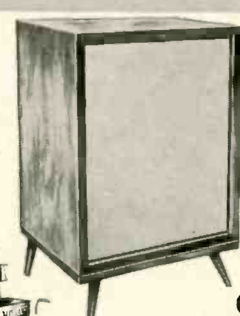
KINGDOM CABINETS

Designed for 8″ speakers or 2-way systems. Made of hardwood half-inch thick. Acoustically correct for excellent reproduction with LORENZ speakers and other standard speakers. Size 13″ x 16″ x 19″.

Available in colors to harmonize with the following finishes:

No. MB-1 Mahogany, Net....$26.95
No. LB-1 Blonde, Net $26.95
No. UB-1 Unfinished, Net $24.45





Note: You know that speaker sound depends on the enclosure and the room in which it is placed. Kingdom cabinets designed for Lorenz speakers give excellent "realism" and "presence," and fit any living room. We have also found by actual test that the Rebel IV CABINART and the Baronet by Electro-Voice are also good. Other well-designed cabinets should work equally well.

KINGDOM SOUND COMBINATION CABINET WITH SPEAKERS

Features the Kingdom cabinet size 13″ x 16″ x 19″, acoustically correct and completely assembled with LP 215 Lorenz speaker, Lorenz SP-65 Tweeter and Kingdom HP-1 High Pass Filter matched to give you maximum listening pleasure at all levels. Available in colors to harmonize with the following finishes:

No. MB-1x Mahogany, ... Net $69.50
No. LB-1x Blonde, ... Net $69.50
No. UB-1x Unfinished, ... Net $67.00

CHAIRSIDE STAND

Sturdy attractive stand converts cabinet to a versatile occasional piece.

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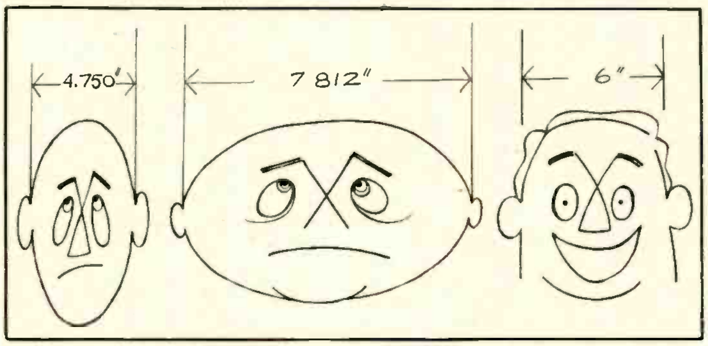
See and Hear them at the Audio Fair, Hotel New Yorker, Room 737

self in this same range for distress calls and involuntary cries, such as screaming.[1]

The corollary immediately develops that for the practical case, such as the cat and the mouse (practical at least for the mouse), or for binaural music, *there is no binaural perception worth mentioning* at frequencies lower than one-tenth the frequency of maximum sensitivity. Thus, the binaural audio system does not suffer for 6-in. humans if it subsides into monaural for fundamentals under 100 cps.

The living room filled with two-channel music from two loudspeakers or from a single binaural speaker[2] affords an essence of enjoyment unapproached by the point source of sound. Like the single-source "hole-in-the-wall" single-channel record player, two-channel sound is listened to with both ears; we do not plug one ear when listening to an ordinary radio or record player just because it is known to be monaural. No matter how the sound medium may have been described—monaural, binaural, stereophonic, 3-D, or in sixteen syllables—it is still perceived by people with two ears in the normal case.



What Are we Trying to Accomplish?

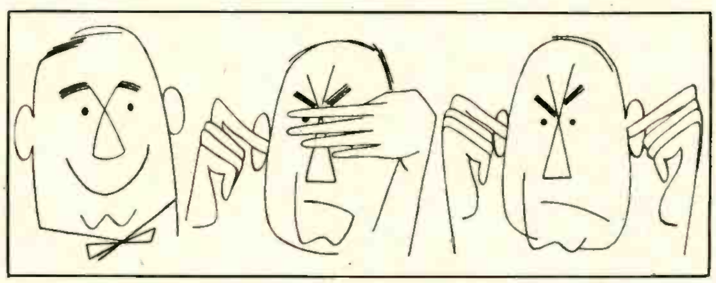
There may be a surprising acceptance of earphones by apartment dwellers for late night listening, but basically our two-channel systems will involve loudspeaker reproduction. So if we are to listen with both ears in a room filled with music, the problem is this and this only:

We must create in the free air around the two ears of the listener an apparent acoustical environment akin to the acoustical dispersions encountered in the original concert hall at the time of the performance.

In order to accomplish this, the listener or user is in equal partnership with the recorder, for either one can spoil the broth, yet neither can correct for the others' mistakes. The healthy and cooperative spirit thus engendered between the two calls for creative effort on the part of both. Speaker spacing and position must not be *outre;* neither may bare living room walls and floors be allowed to dominate the acoustics.

Confusion of Terms

"Binaural" has been and is currently defined by Webster and other leading lexicographers, and its associative meaning to the non-hi-fi mind does not imply a specific or precise set of conditions. Instead it is a general term. If the audio field is ever to embrace new blood, tutored in Webster, but fresh, innocent, and untutored in the devious workings of the engineering mind, perhaps it would be as well if we did not attempt to re-define Webster. Therefore it is suggested that according to present general usage, the omnibus term "binaural" be allowed to continue on its way, and that the 6-inch microphone systems, fifteen-foot speaker systems, and all the other present and future philosophies be assigned individual qualifying adjectives. Like the wise, far-sighted Duke of Dannemora, we never know when our noblest words may incarcerate us. Obviously the detractors of binaural sound have nothing to lose and a lot to gain. Practical binaural is probably the only development in the speckled history of audio which leaves everybody concerned in a better frame of mind. Even the final user is happy, and stays that way!



Cost

There is no basis for the inexplicable rumor that binaural is a "millionaire's medium." A basic audio system consists of a turntable, arm, preamplifier, amplifier and speaker. A binaural speaker in a single cabinet is now on the way at no additional cost, a binaural amplifier is coming at only 20 per cent additional, the preamplifier is already here at no premium cost at all. The arm price is the same as that for ordinary arms of comparable precise construction, and all the items are directly compatible for ordinary record playing. We do lose out on the cartridge—inexorably twice the cost, or double in diamonds, so to speak. But all together, two-channel sound is hardly any more expensive than ordinary sound. Even the records cost no more.[3]

Surprising Benefits

We all must know by now what the binaural medium is capable of accomplishing, but there are unsung and curious dividends that need to be expounded. Among them are:

Dynamic Range. The dynamic range is shocking to the confirmed single-channel listener. In a good job of pickup the reproduced acoustical dispersions give strong clues to the relative original loudness. When the orchestra strikes a triple forte the reverberative patterns tell us inevitably how loud it must have been, even if the volume is turned low, and thus it seems to be loud anyway. And in quiet moments, the dispersions again define the proportional loudness unmistakably. In recording, to change the volume control setting (compress or expand) is a signally fatal error. It fools nobody in binaural listening, raising in the midst of a moment of relaxed enjoyment the ugly connotation of having been ejected from the tenth row into the balcony at the start of the fourth movement.

Loudness. In an engineering sense, the addition of a second channel of equal power in a random r.m.s. way might be the equivalent of a level increase of 3 db—captious and unnecessary. But two and two do not make four; the apparent loudness grows mightily, for we have a frame of reference well-linked with reality. Again, the basic engineering answer—like color TV, five to ten times the amount of information per unit time is communicated to the user, and imagination, instead of having to work overtime to supply the missing, is instead resting up for the next session with monaural. However, unlike color TV, the binaural machine is forwardly and backwardly compatible with ordinary records, groove-shapes and characteristics.

Back to the overworked imagination. We all know after a brief experience with hi-fi that there is an irritating tendency on the part of those who play

(*Continued on page 76*)

[1] (*We specifically disclaim the implication that a high pitched hysterical scream might be assumed to have emanated from a female with an abnormally narrow cranium, lacking any corroborative information.* Ed.)

[2] Bozak

[3] Making binaural records is like making smoked glasses for atomic bomb explosions. The market is temporarily restricted, but has a promising future.

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Fine Music

AND HOW TO REPRODUCE IT IN YOUR HOME...

A man once said about art—
"Away with your oils and brushes, your chisels and chips, for these are hypocritical rubbish! Show me only the finished picture, the completed form."

No one remembers this man's name, because so few people agreed with him. In the art of recreating the living, breathing reality of beautiful sound in your own living room, the tools which enable this accomplishment are all important.

It is the purpose of these pages to tell you something about the properties, capabilities and methods of using these new tools. In this way you will be able to make a selection compatible with your requirements.

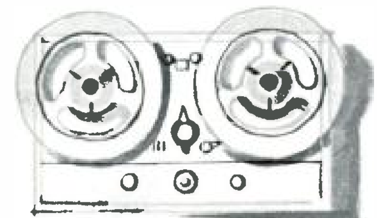
These requirements should take into account the space you have available, the number of music sources you wish to employ, and the amount of money you care to spend.

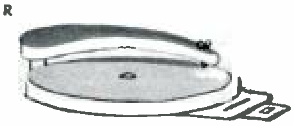
A vast, new world of listening pleasure awaits you.

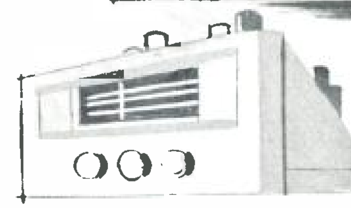
Text by Howard Souther ELECTRO-VOICE, INC.

THREE TYPES OF EQUIPMENT ARE NEEDED

FOR HIGH FIDELITY REPRODUCTION

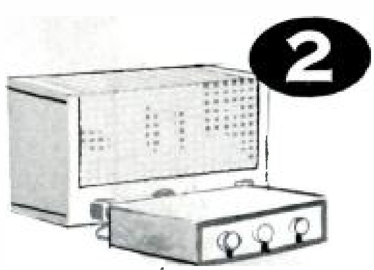






1 The Source

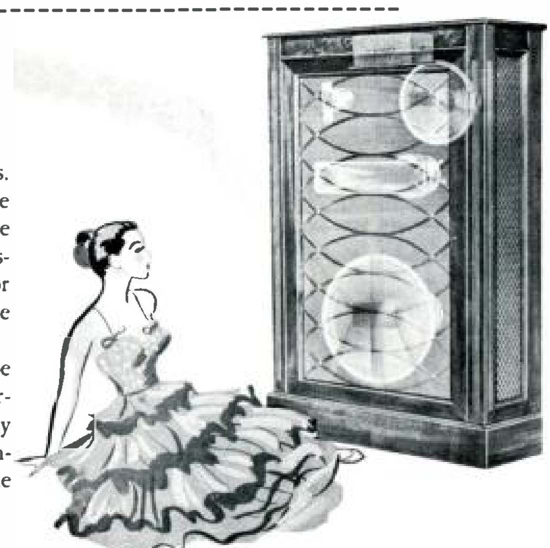
There are three kinds of sources for home high-fidelity listening: The record reproducing mechanism, a radio tuner, and a tape machine. You may use an automatic changer or manual record player, or both. If you are within 75 or 100 miles of a metropolitan listening area, the radio can provide a wonderful source of good music. The tape machine is your finest source, and can also be used for recording and storing choice radio programs, and for transcribing your better phonograph records to permanent form in order to eliminate deterioration through repeated turntable use.



2 The Amplifier

The minute energy usually available from the source must be amplified to a level approaching the power found in the original music. The control section of the amplifier is highly important for it compensates for changes in musical balance in the various sources employed. It also regulates the level of sound in your living room. Any one of the above three sources may be selected at will through the one amplifier.

3 The Speaker System



The loudspeaker system consists of two principal components. The first of these is the driver or drivers which translate the electrical energy from the amplifier into acoustical power. The second component is the baffle, or horn, which couples the acoustical energy to the outside air of the living room. The baffle, or horn, and especially the outside housing, can make the entire assembly a decorative and functional furniture piece.

The speaker system is the most important equipment to be considered, for the widest variations are to be found in the performance of various types. This means, too, that it is potentially the weakest link in the sound reproducing chain, and that considerable importance attaches to its choice, for the qualities of the other components manifest themselves through the speaker.

Yours to Enjoy, the Magic of High-Fidelity Reproduction

BUT FIRST—

WHAT IS MUSIC...

In order properly to choose the tools for creating a grand new world of beautiful sounds in the home, we must first discuss the final object of our efforts.

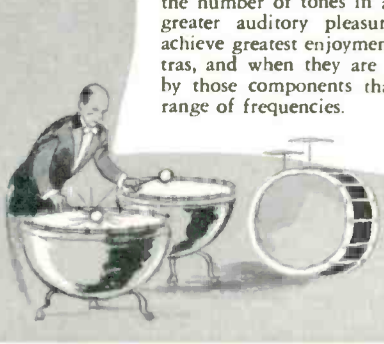
This objective is the reproduction, in the minutest detail, of the actual experience of tonal reality. Paradoxically, the requirements for perfection need not be too strongly stressed. In high-fidelity home reproduction there is an easy accommodation to the greatly reduced volume level of the symphony orchestra performing in a large concert hall. There is also a comfortable agreement to the restricted spatial effects occasioned by our own smaller listening area. These compromises are assisted vastly by the modern wizardry of the design engineers, who subtly adjust the response and balance of their equipment to enhance, in many cases, the thrilling life-like qualities of the original performance.

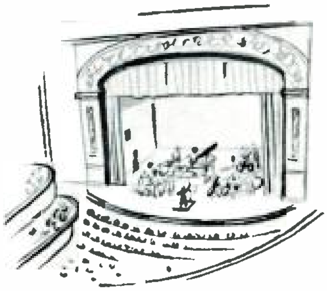
How the Human Ear Hears Musical Sounds...

RANGE OF SOUNDS All music consists of complex sounds, or vibrations, in the air. These vibrations range from 16 beats per second to 16,000 pulses, or beats, per second. The lowest of the great tones generated by a 16 foot organ pipe consist of 32 beats per second; the highest musical sounds are the delicate 15,000 cycle overtones observed as higher harmonics of the brilliant clash of the cymbals, the stirring snares of the drums, and the triumphant blare of the brasses.

RHYTHM The very framework of musical composition is rhythm. It is in the stirring beat of the tympani, the snares, the bass viol, and often the piano, that we find our pulses quickening in tune. Rhythm is derived predominantly from the bass sections. This fact serves to point up the importance of low response range considerations in choosing the three important elements of our music system.

VARIETY The brain, through the ear, delights in the stimulus promoted by sounds which are musically related. This musical relationship implies also a mathematical relationship, for the pleasing higher harmonics are multiples of the vibration rate of the lower tones. It follows that increasing the number of tones in a related order results in greater auditory pleasure. For this reason we achieve greatest enjoyment from the larger orchestras, and when they are reproduced in the home by those components that encompass the widest range of frequencies.





DYNAMICS The transition from a soft passage in musical composition to a louder one is carefully calculated by some composers to achieve a physiological effect. Usually this buildup in volume level is achieved through a succession of pre-climaxes, until the full fortissimo is reached in a compelling crescendo, followed by instant cessation to breath-taking quiet.

The volume range enabling this sort of performance is termed the *dynamic range* of the particular sound system, and depends partly on the quality of the source, the FM radio and the tape recorder being the best in this regard. The power handling ability of the speaker system and amplifier determines the upper limit of sound level, but the *overall* quality of the components decreases the hiss, static noises, and scratch. This extraneous noise determines the very important lower limit for the pianissimo phrases in the composition.

THE LIMITS OF AN ORDINARY COMMERCIAL RADIO OR RADIO-PHONOGRAPH

Contrasted with Extended Range High-Fidelity Reproduction

The ear is a very accommodating mechanism. Lacking a basis for comparison, the ordinary radio and radio-phonograph has appeared to be tolerable to the listening public. But the advent of high-fidelity listening has provided a comparison, and the discriminating listener now finds it possible to articulate his dissatisfaction. The high-fidelity reproducing art purveys as much as 9 octaves out of a possible 10. It can be demonstrated that the commercial radio or radio-phonograph can reproduce only the middle of the audible spectrum, and that even this range is available only in the exceptional cases. Here are the reasons:

ORDINARY RADIO RESPONSE RANGE

The type of response with which we are most familiar from the usual home set covers a range of only 5 octaves, or from 125 to approximately 5,000 cycles per second, in spite of the fact that frequently another full high octave is broadcast.

The restriction in the upper range is due to two causes. First, the Federal Communications Commission limits for AM transmission permit a minimum response of 5,000 cycles per second. Secondly, the usual telephone lines feeding network programs cut off at this same response.

This cut-off does not hold true on FM programs of local origin. Here the full band of frequencies is available to the listener. The usual set manufacturer exploits only the noise-free features of FM since his product—because of poor speaker, amplifier and tuner—cannot reproduce the wide frequency range FM provides.

USUAL PHONOGRAPH RESPONSE RANGE

The ordinary phonograph usually utilizes the old style 78 RPM shellac pressings. The rough, granular structure of the record material causes scratch, the predominant scratch frequency being 5,000 cps. This explains why the usual phonograph cuts off at about 4,000 cycles, or lower than the predominant scratch frequency. The new Vinylite records have not only eliminated most of the objectionable scratch, but have also greatly increased the frequency response range. In spite of this, the mass set producer can only stress the long-playing feature of Vinylite records in view of the inadequacies of his components.

BASS RESPONSE IN THE USUAL RADIO-PHONOGRAPH

The tenets of musical balance demand that the upper limit of response multiplied by the lower limit of response shall equal the figure 600,000. With the upper limit as 5,000 cps imposed in the preceding paragraphs, the ordinary set must forego the first three octaves and begin bass reproduction at about 125 cps, which is the lower part of the fourth octave.

Even if additional bass were incorporated in the ordinary radio-phonograph, it would be utterly impossible to use it for many reasons. For one, the powerful impact of the drum-beat would communicate itself from the speaker through the cabinet, and into the sensitive phonograph needle. This would cause what the engineers call "acoustic feedback," and result in a low, sustained growl, similar to the high pitched whine we experience when we place an ordinary telephone receiver near the mouthpiece. In contrast to the usual radio-phonograph console, we find always that ***high-fidelity music systems separate the loudspeaker from the record player and tuner location by as much as several yards whenever feasible.***

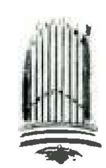
Heavier and more costly components are necessary in the amplifier and speaker to produce these bass tones. Somehow, the economics of commercial radio-phonograph design have never taken this into account.

the important subjective effects of various portions of the audible spectrum

FIRST OCTAVE
16–32 CPS
The Threshold of Feeling and the Region of Low Frequency Wind and Room Effects

The region of the first octave contributes much to the illusion of reality. The low swell tones of large organs generate sub-harmonics in this range. While two fundamental tones in the second octave only may be involved, the *difference* in vibration between these two higher tones results in a powerful beat in this first octave. These very low beats are part of some musical composition and account for the thrilling feeling of power derived from the organ, the largest of all musical instruments.

Only the most extensive high-fidelity installations permit these lowest tones to be generated. One such installation is shown on the last of these pages. Fortunately, almost all serious music confines itself to the octaves above 32 cps, so we can still appreciate keenly the most comprehensive musical passage without absolutely requiring this difficult part of the spectrum. Then, too, most source material lacks these lowest frequencies at the present time, and we must await the future years in order to achieve their full employment.



SECOND, THIRD, FOURTH AND FIFTH OCTAVES 32–512 CPS
The Lower and Upper Bass Regions which Lend Body and Rhythm to the Performance

The minimum response range necessary for the communication of intelligence lies in a band only 500 cps wide in the seventh octave, at about 1,500 cps. Reproduction confined to this band somewhat resembles the pinched quality we find in the telephone. Missing are some of the fundamental tones of speech in the lower part of the fourth octave. The low, grave tones of the drum and piano are generated in the second and third octaves. The result is fullness and richness in the performance. The rhythm of the music is most forcefully communicated through these octaves.

Exaggerated bass response in the third and fourth octaves results in boominess. This is the objectionable "juke-box" quality the music lover finds so disquieting. It is prevalent to a high degree in the commercial radio-phonograph, due in large measure to the open-back loudspeaker compartment.

SIXTH AND SEVENTH OCTAVES
512 TO 2048 CPS
The Important Region for Bare Communication of Intelligence — Telephone - Like Quality

The ear is reasonably sensitive in this range, and almost all reproducers manage this mid-range with facility.

If the sixth octave is made louder with respect to other octaves, the music has a horn-like character. If the seventh octave (1,000 to 2,000 cps approximately) is emphasized, we achieve a "tinny" effect. Recordists, and others engaged in listening to reproduced music over long periods, find that "listening fatigue" can be very much reduced by attenuating the sixth and seventh octave range to about three-fourths of the usual level.

EIGHTH AND NINTH OCTAVES
2048 TO 8192 CPS
The Vital Presence Range So Necessary to Lower Level Listening

Granting reasonable response in the lower octaves, augmented power in the eighth and ninth octaves does more to promote the magical illusion of "presence" than any other part of the spectrum. At the usual listening levels in the living room, the ear is most sensitive in this part of the range. These frequencies also form labial sounds and the fricative consonants in speech. The musical instruments approaching the human voice in timbre and vibrance are assisted here immeasurably.

It is in this range also that improperly designed speaker systems begin to beam the sound and concentrate it in certain portions of the room, generally on the axis of the reproducer. The additional energy serves to fill in the missed portions of the room by reflection and moderate a "distant" and "dull" effect due to absorption by draperies, rugs and furniture.

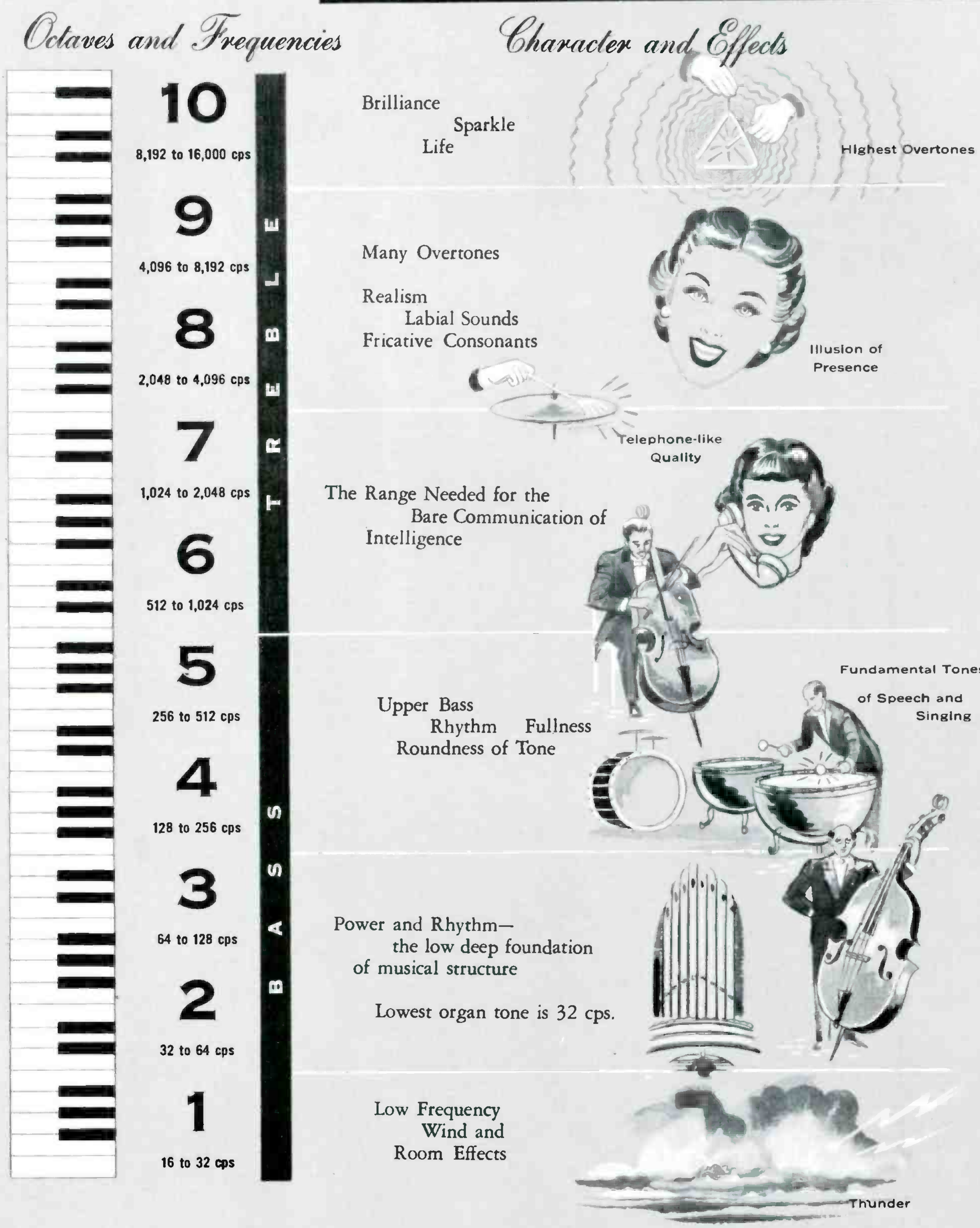
The lack of response in the vital "presence" region in ordinary radio-phonographs characterizes them immediately as "low-fidelity."

TENTH OCTAVE
8,192 TO 16,000 CPS
The Final Touch in Completing the Illusion of Reality

Most individuals have the ability to hear sounds extending to 16,000 cps. This auditory acuity at the extreme high range degenerates to about 12,000 cps at 60 or 70 years of age.

The delightful sparkling quality which we appreciate as brilliance in the music is found in the upper part of the ninth and the tenth octave. Effervescent, tingling—the upper harmonics of many instruments find at least some expression here. They are not missed too much by our ears if they are left out of the reproduction—but like froth, they complete the picture of the wave, and serve to perfect our illusion of musical reality.

THE WORLD OF SOUND



THE FORMS OF DISTORTION IN MUSIC REPRODUCTION

Distortion in high fidelity reproduction means simply that something has been either added or subtracted which did not exist in the original performance.

AMPLITUDE OR LEVEL DISTORTION

When we play music in our home at a lower or higher level than that at which it was originally recorded, we have introduced amplitude distortion. This form of distortion *need not necessarily* be bad; sometimes perforce we must moderate the level out of deference to less appreciative neighbors. Engineers have provided us with compensation controls in the equipment which offset the deleterious effects of this changed level. Observe the figure which shows the manner in which the ear responds to the lower level of sound. The bass frequencies are much lower than they should be, and proper amplifier equipment provides a boost for these tones to which the ear has now become less sensitive. This same control affords also an accentuation of the extreme high register to adjust for this further lack of lower level responsiveness in the ear. Not found in other than the strictly professional equipment, however, is the ability of the amplifier to add a desirable mid-high boost in the vital "presence" range at 5,000 cps. There is at least one loudspeaker system on the market that today provides means for augmenting this requirement for ultimate low-level listening.

HARMONIC DISTORTION

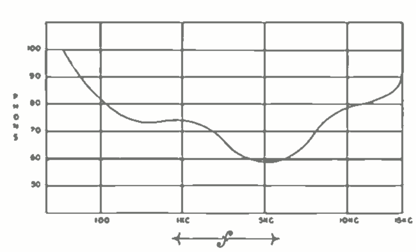
It is the nature of all physical things to emit a tone at some fundamental mode when set in vibration. There are also an infinite number of other modes of vibration usually at a much lower intensity than this fundamental. This vibration can not only be mechanical, as in the pickup cartridge of the record player and speaker system, but can also assume electrical form in the amplifier. These are spurious tones not present in the original music, and if they assume certain intensities are very trying to the ear. For example, the average ear detects 3 per cent distortion, tolerates 5 per cent and rebels at 10 per cent.

Specifically, the sources available to the music reproduction enthusiast are usually under 3 per cent in distortion content. The amplifier possesses less than 1 per cent, and very good speaker systems keep the total just under the 5 per cent mark.

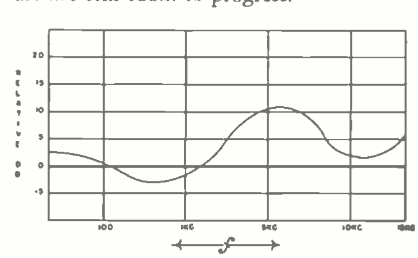
INTERMODULATION DISTORTION

While harmonic distortion consists of multiples of the fundamental tone, intermodulation distortion is caused by beats which are the *difference* between two tones. The most objectionable beats are those due to higher tones close together causing a low frequency beat between each other. The major disturbance is due to the contrast offered between erroneous low and high tones.

These distortions are easily measured in amplifiers, and explain why the amplifier is the most perfected of our tools for reproducing music. In the acoustical and mechanical parts of our system the amounts of distortion are determined more or less empirically. The art has still room to progress.



EAR SENSITIVITY . . . Heavy line represents room listening level; curved line indicates level which should be added to high and low parts of the spectrum to make music and speech appear balanced.



LOW-LEVEL SYSTEM RESPONSE . . . Present ideal speaker or system response to relieve "distant" effect at room playing levels. 3,000 to 6,000 cps rise adds "presence."

HOW TO CHOOSE THE COMPONENTS FOR YOUR HOME HIGH-FIDELITY MUSIC SYSTEM

In the next several pages it may seem that we become intricately and trivially concerned with processes. But the miracle of recreating the original experience of beautiful music demands that we carefully evaluate and judiciously select the tools for the process—for even miracles must have processes of some kind, however instantaneous they may be.

the cartridge and record player

The long-playing phonograph record is currently one of our most popular sources of high-fidelity music. The granular structure of the record base is exceedingly fine, and thus, the effects of scratch are minimized. Because the objectionable noise level is so low we are able to realize the dynamic range so important to the proper translation of musical composition.

The recorded groove in the phonograph disc is a storehouse in the form of a curved matrix of the original sound. The phonograph cartridge is designed to follow the contours of sound groove, and to retranslate the mechanical energy thus generated back into electrical form.

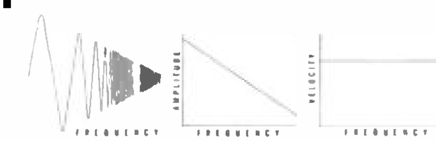
Because of the physical limits of the record, such as size and speed of rotation, certain compensations are needed in the process of storing the music on the record. This calls for complementary compensations in picking up the energy from the record at the instant of playback, and the quality and design of the cartridge and associated amplifier controls determine critically the fidelity of the reproduction.

THE CARTRIDGE

There are two general types of cartridges, the new ceramic or barium titanate constant amplitude cartridge, and the magnetic, or reluctance constant velocity type. Both types of cartridges are excellent, in spite of the additional preamplifier needed for the magnetic type. All high-fidelity amplifiers currently provide this "preamp" however.

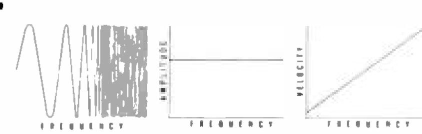
There are three ways of cutting the record groove with the electro-mechanical equivalent of the music:

1 CONSTANT VELOCITY



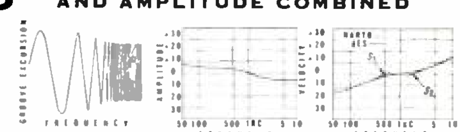
The frequency excursions are progressively limited with increasing frequency to keep the stylus tip velocity constant.

2 CONSTANT AMPLITUDE



The frequency excursions are held constant for all frequencies recorded.

3 CONSTANT VELOCITY AND AMPLITUDE COMBINED



This is the modern Audio Engineering Society recording characteristic, presenting an agreeable compromise using velocity sensitive cutters. It utilizes constant amplitude in the bass region, constant velocity in the mid-range, and attenuated constant amplitude for the critical higher frequencies. Thus, the resultant recording allows more use of the recording space and gives essentially constant amplitude response.

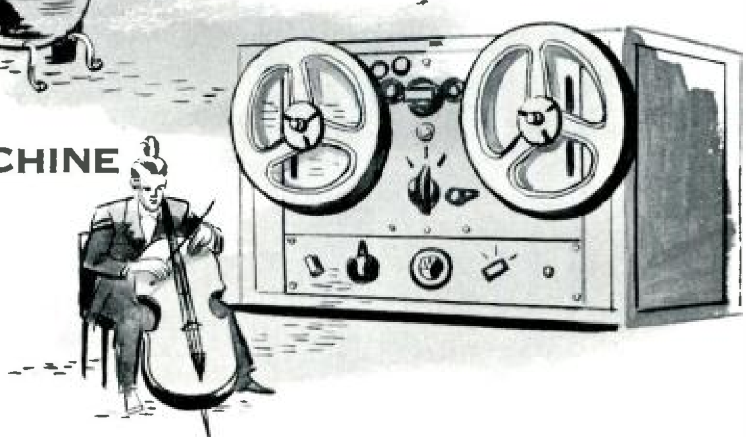
With a cartridge which responds linearly to constant amplitude, such as the new ceramic type, no playback equalization is required for the bass, and the cartridge design itself compensates for the high end pre-emphasis. With the magnetic or constant velocity cartridges, a preamplifier is necessary to boost the bass energy, and to effect flat response in the highs.

The transcription type turntable is the best today, because it is professional equipment with a powerful, smooth motor and heavy, flutter-free turntable.

THE RECORD CHANGERS of the high fidelity type are uniformly excellent with only a slightly noticeable amount of rumble and wow, even at the very lowest frequencies. Improvements are being made, and several manufacturers today produce changers which compare favorably with the transcription manual players. Excellent results are possible, and the record changer is invaluable for continuous unattended playing when the music system is employed for low-level background at dinners, gatherings, and for mood inducing while resting or reading.

THE RECORDING COMPANIES are constantly refining their product; certain selected recordings leave little to be desired in technical and artistic perfection. On the other hand, the serious listener must learn to discount defects in some pressings occasioned by deformed stampers used in processing the record, scratches, and ticks and pops incident to impurities in the record base.

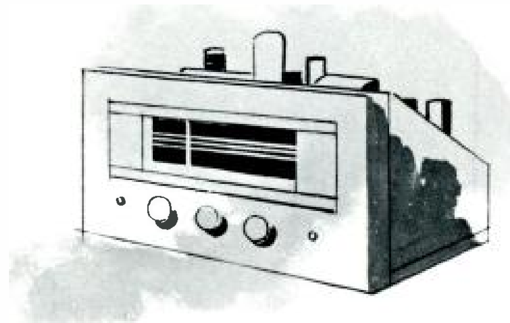
THE TAPE MACHINE



The tape machine is paramount as a source for good music because of its freedom of background noise, its wide dynamic and frequency range, ease of operation, and permanence of the recording. It is a secondary source to the record player because of the paucity of the pre-recorded tape libraries available to the user.

The music lover will choose certain programs from FM radio and record them to form part of his permanent library. Frequently, these are of such high quality that it is difficult to discern differences between such recordings and a live program. The cleanest of the long-playing records can be transcribed to tape before wear and scratch have built up, and thus can be preserved indefinitely in their finest state. The true high-fidelity hobbyist will take his tape equipment to local music functions and interpret the performance through the medium of his machine and his own artistic ability.

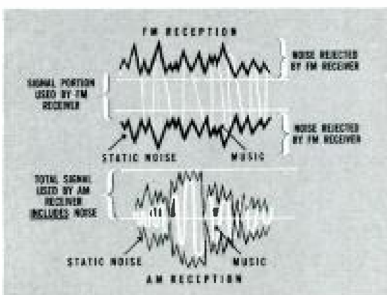
Currently the 15 inch per second tape speed at "full track" delivers top quality and full range. Satisfactory response to 12,000 cps is available on lower price tape mechanisms at 7½ inches per second, sometimes on half track. Using only one-half of the track at a time at 7½ inches per second quadruples the amount of material which can be stored on the tape reel over that possible at the full track 15 inch per second speed. The slower speed has less dynamic and frequency response range, more flutter and consequent distortion. The 3¾ inch per second tape speed is strictly "low-fidelity" at present.



THE TUNER

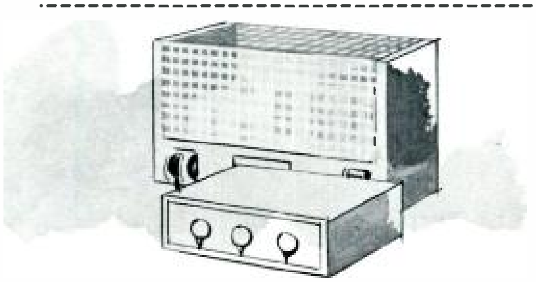
AM radio programs played through the usual superheterodyne tuners cannot be considered within the concept of high-fidelity as expressed in these pages. The restriction in high-frequency response range to less than 5,000 cps puts such reception strictly into the "low-fidelity" category. But in high fidelity AM-FM tuners, reception is not so restricted in range possibilities, nor is it subject to the high noise levels on FM. This high noise level compresses the all important dynamic range.

Many excellent combination AM-FM tuners are available on the commercial market. The combination tuner allows AM to be used for "mood-music" and pleasant background, and affords FM for the serious listening to the finest radio programs.



The diagrams show how AM is affected by static noise, and the method by which FM subdues these extraneous and disturbing effects.

The considerations in choosing a tuner are few, but extremely important. The selectivity, or ability to separate various stations, depends on the number of "tuned circuits," generally indicated by the multiplicity of tubes in the forward portion of the assembly. Inherent noise in the tuner is kept at a minimum. The general criteria of excellence in tuners are the larger number of tubes employed, and the higher overall cost.



THE AMPLIFIER

AND ASSOCIATED CONTROLS

The high-fidelity amplifier is composed of two sections, the preamplifier and the main, or power amplifier.

THE PREAMPLIFIER:—

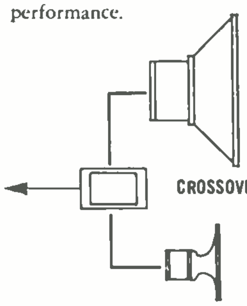
The preamplifier receives the infinitesimally small electrical energy from the source equipment, and amplifies it anywhere from 10,000 to 1,000,000 times, concurrently equalizing the musical balance for various levels of listening, compensating for different recording characteristics on various makes of records, and at the same time permitting the listener to adjust bass and treble to local acoustic conditions. When we amplify the signal to such tremendous amounts, we must guard against the introduction of noise and hum, which would decrease the dynamic range possibilities of our system. It is in the preamplifier that we find the great differences between one make of amplifier and the next. For instance, the selection of record reproducing characteristics is possible only on the more expensive ones. Others have a range of bass compensation calculated to complement the folded corner horns to be treated on in later paragraphs. Too, the quality of the component parts and the ingenuity of design determine residual noise and hum, the important factors in maintaining wide dynamic range. No preamplifiers at this writing provide for emphasizing the "presence" range between 3,000 to 6,000 cps. This necessary compensation for low-level playing in the living room must be found in the loudspeaker, and will be dealt with in the next section.

THE MAIN OR POWER AMPLIFIER:—

The main or power amplifiers are uniformly excellent in the assemblies selling for $50.00 or more. Distortion is kept at fantastically low figures, on the order of one and two tenths percent at good playing levels. Ten watts output is required for the bass peaks of usual room playing levels, which average out at about ½ watt. A 20-watt amplifier preserves a margin for safety.

the loudspeaker system...

Leonardo de Vinci used the genius of his science to promote the glory of his art; he employed technology to project his true perspectives and to mix his colors; he used his subjective sense to imprison light-like Ariel in his web. In today's experience of listening to the masterpieces of high-fidelity sound, all of the science *and* art of a vast multitude of engineers, designers, artisans, and artists find its meeting place finally at the loudspeaker system in your living room. The choice of the loudspeaker system requires importantly a technical as well as a subjective knowledge of its function and performance.



HOW THE LOUDSPEAKER WORKS

The loudspeaker in its most simple form is a motor and piston assembly. The motor moves the piston in conformance to the variations in the electrical counterpart of the music from the main amplifier.

The piston compresses and rarefies the air in our listening area in the form of waves. These waves are perceived as sound by the brain through the ear. The problem in designing a loudspeaker lies in the inability of the piston to set the air in motion uniformly at all frequencies of vibration.

two ways exist to extend the range and to lower the distortion

Two methods are used currently by the acoustical engineer to promote uniform propagation of all the tones. The first of these methods is to divide the audible spectrum between two or more drivers, or pistons. Smaller drivers are used for the higher, more rapidly pulsating tones, so that the lighter mass of the piston can trace the delicate overtones of higher instruments. The larger pistons, in the form of cones, follow with facility the powerful slower oscillations of the bass tones.

COAXIAL SPEAKERS

Sometimes the high-frequency speaker is mounted inside the cone of the bass driver. The virtue of this arrangement is almost wholly one of accession to the public's desire for integrated assemblies. Good dual, or coaxial units of this type usually have high crossover points, and unequally divide the load between the high and low drivers. The ideal crossover point for two units is about the fifth octave, whereas coaxial loudspeakers, because of space restrictions and interference effects, must cross over between the seventh and ninth octaves. The fact still remains that the determining factor in the generation of optimum bass response is space in the housing.

MULTIPLE-WAY SYSTEMS

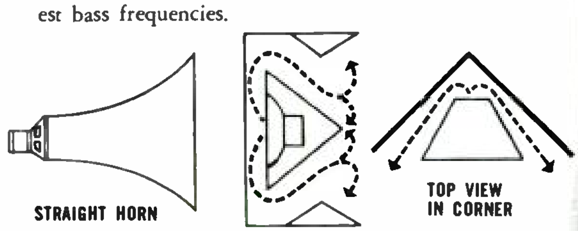
Further divisions of the audible spectrum can be made with added, specialized, separately mounted driver units. In addition to insuring the maximum extended range, the higher harmonic distortions generated by the lower speakers are cancelled out by the electrical network which feeds them their respective portions of the spectrum.

THE MAGNET

A speaker system which was 100% efficient would be a perfect transducer of electrical energy into acoustic energy. Present day quality systems fall far short of this, being somewhere near 50% efficient only. This means that certain bands of frequencies must be damped down to the level of other bands in order to smooth the response. This is done properly with expensive magnets, and controlled narrow tolerances in the construction. These factors increase the complexity and cost of the structures. The magnet weight may be used generally as a guide to evaluating excellence, particularly in low-frequency drivers.

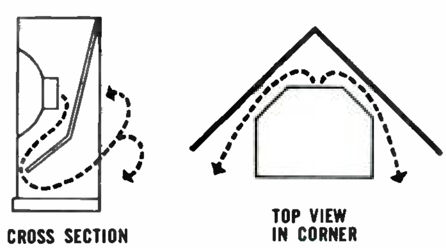
Horns, Baffles and Enclosures for the Speaker System

The second method of smoothing response and lowering distortion is to couple the area of high pressures near the pistons of the drivers to the outside air in a gradual manner. This is accomplished ideally by horns. Sometimes these horns are folded, and use the corner of the room as an extension of the horn mouth. In this manner, a pleasing furniture appearance can be effected with a minimum of space. Unfortunately, the best speakers are usually the largest, because of the inherent requirement for operative space for the lowest bass frequencies.

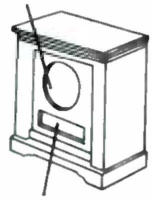


KLIPSCH-TYPE FOLDED CORNER HORN

The smaller horns have crossover points situated at 800 cps or higher. In this case the frequencies from 200 cps up must be supplemented by front radiation from the bass driver. This is for the reason that these higher bass frequencies cannot follow the circuitous path of the folds.



"Bass-reflex" is the term used to cover a more simplified type of baffle. These are usually 5 to 8 cubic feet in size and possess a port which reinforces the bass in the third octave. Unfortunately, immediately after the reinforcement peak, rather violent attenuation of the lower frequency energy takes place. The musical balance is nonetheless better than with no port at all.



The "infinite baffle" implies mounting the speaker in a wall or closet. Next to the larger folded horns, this form of mounting is the best. With 18 to 25 cubic feet behind the bass driver, it outperforms the bass-reflex design and exceeds it by far in purity of tone.

The use of 35 or more cubic feet delivers a smooth, augmented base range exceeded only by the "Klipsch" indirect radiator types illustrated.

Whichever you choose of the above enclosures for the speaker or speaker system, much more range and purity will be achieved than that afforded by the conventional "open-back" radio-phonograph console acoustic system.

THE ROLE OF THE DEMONSTRATION

in choosing components

The loudspeaker system should be selected first, for the performance of all the other components must be judged through it. Evaluation by printed specifications is difficult because few standards exist at this writing for properly qualifying the response range and distortion products, particularly of the speaker system. Some manufacturers may claim high-frequency response to 20 or 25 thousand cps, and be very factual in the unqualified claim; they fail to state that the energy at this frequency is so low as to be almost immeasurable. Others may state "flat response ±2 db to our performance standard," without stating of what the *performance standard* consists. Unless you are an engineer and can properly interpret the qualifications, or the lack of them, it is best that you let your own ears be the judge.

Insist first, that a clean tape recording be used through one of the best amplifiers. Play the music at a good, full level, so that you can overcome the masking effect of ambient street and store noise. Remember that your ears are insensitive to the extremes of the spectrum at low levels under these conditions. In your quiet home listening you can play at low volume without masking by noise, and properly boost the extremes with amplifier controls for optimum musical balance.

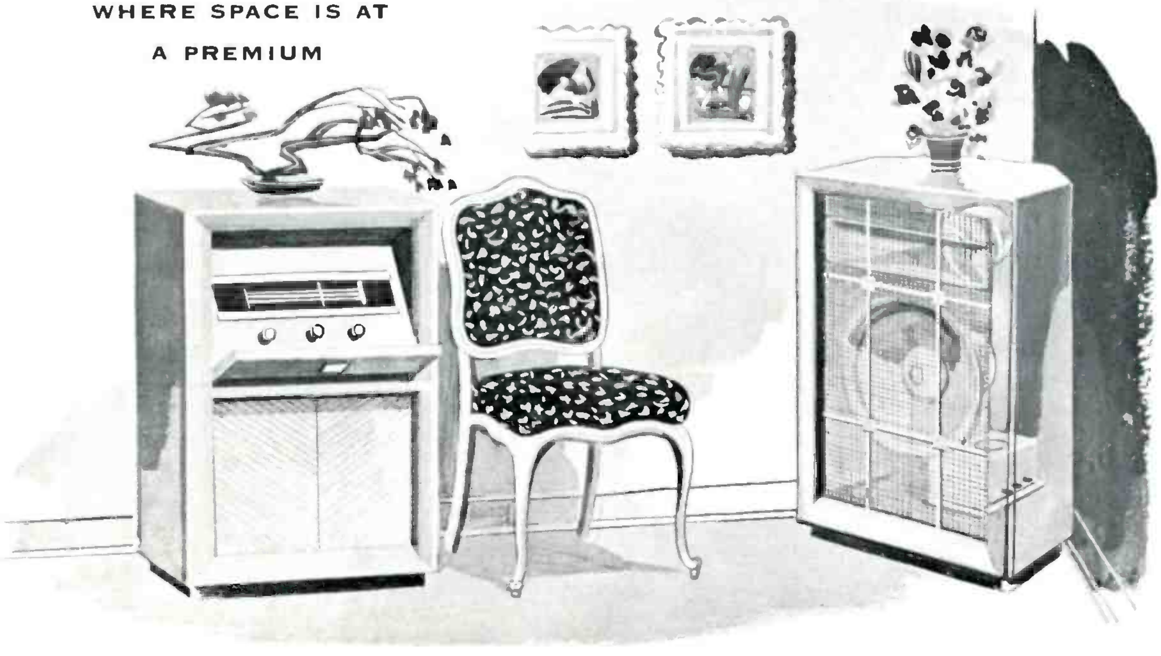
Now, listen for the solid "step-ladder" bass; the bass viol should articulate each tone separately, and not produce a single "juke-box" thump. Listen for a full, rich quality in the high bass region, and a projected "life-like" feeling in the "presence" range of the eighth and ninth octaves. The tenth octave will probably only be apparent if a separate "super-tweeter" is present. You will perceive here the brilliant overtones and highest harmonics.

Next change amplifiers and try regulating the controls. Make certain that the bass can be controlled to produce extreme augmentation; in a quiet living room this will permit the restoring of musical balance at soft volume levels.

Now select your various sources. For the record player test, bring your own favorite record, so that you anticipate the response of certain passages. Your own record also establishes a standard of comparison with any previous music system you may own.

After you have engaged in this rather interesting and enjoyable process of purchasing and installing your sound system, you may, like Walt Whitman, say—*"Now, I will do nothing but listen—Ah, this is indeed music, this suits me!"*

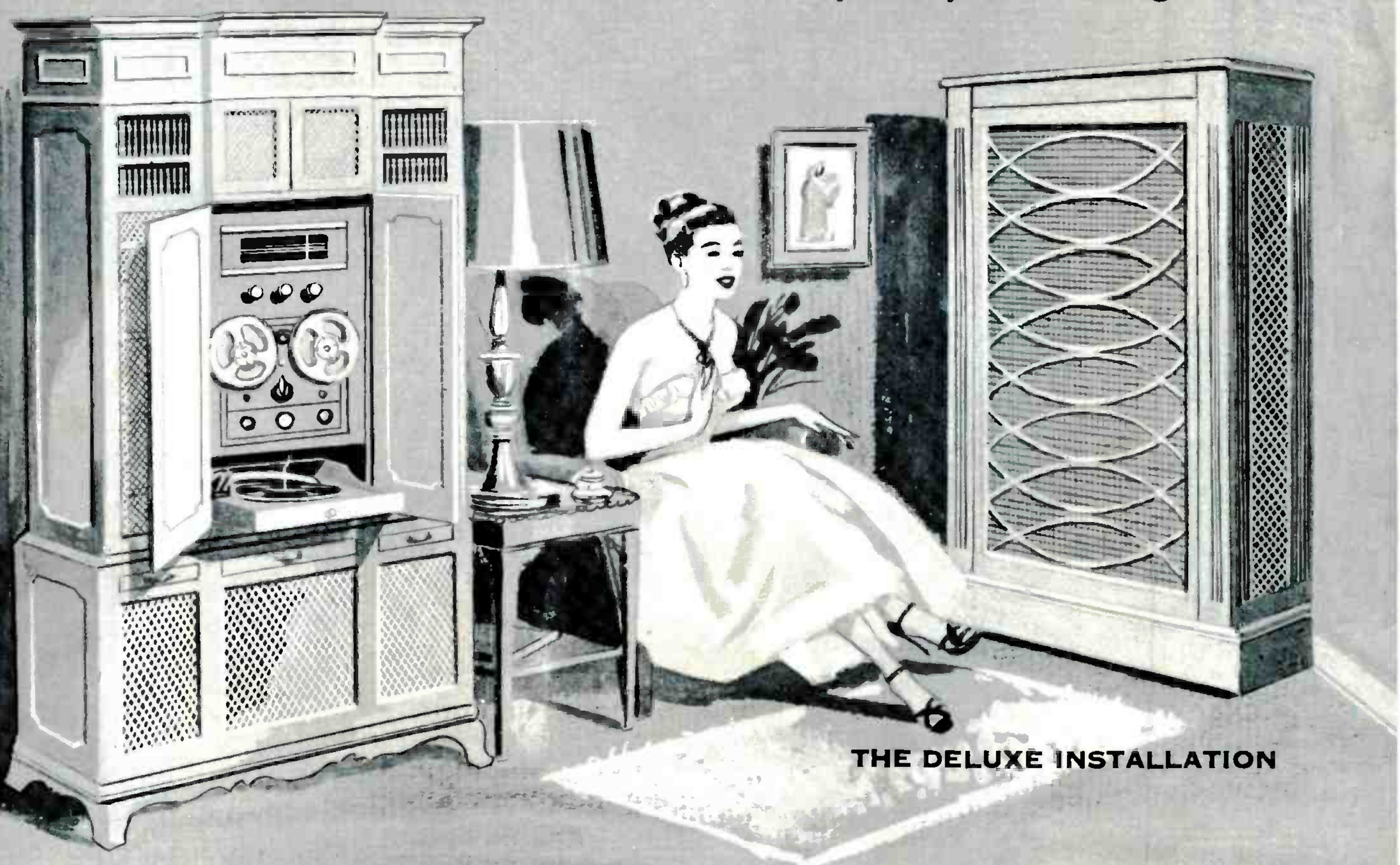
WHERE SPACE IS AT A PREMIUM



UTILIZING BOOK SHELVES AND A LARGER SPEAKER SYSTEM

TYPICAL HOME INSTALLATIONS

for the finest listening..



THE DELUXE INSTALLATION


THE MAGNIFICENT
Georgian
ELECTRO-VOICE
KLIPSCH FOLDED HORN
4-WAY LOUDSPEAKER SYSTEM
Utilizing the Authentic Klipsch "K" Horn Type Indirect Radiator for the Extreme Bass
The luxurious cabinetry of this corner enclosure is skillfully combined with the most advanced high-fidelity engineering to give you a superlative, integrated 4-way reproducer. The magnificent GEORGIAN utilizes the famous Klipsch "K" horn with special EV 15" driver in the bass section. Electrical network makes the first crossover at 300 cps to a compression type, horn-loaded mid-low frequency driver with 58" path length. From 1000 to 3500 cps, a special E-V diffraction horn through an acoustical crossover gives smooth, augmented treble tones. Above 3500 cps, the E-V Super Sonax very-high-frequency driver takes over to provide the silkiest extended high frequencies out to and beyond the range of audibility. This multiplicity of crossover points and the specially designed crossover network permit a smooth transition from one section of the spectrum to another. Besides, the GEORGIAN is the first loudspeaker system ever to incorporate the vital "presence" control as well as a brilliance control. With its cleanliness of reproduction and extended range, you can now enjoy all the reality of living music in your home.
Selected Mahogany or Blonde Korina veneers in lustrous hand-rubbed finish.
53" high, 34" wide, 26" deep.
Includes Electro-Voice 15WK Low-Frequency Driver, 848-HF Coaxial Compression Type Mid-Bass and Treble Driver Assembly, T-35 Super Sonax Very High Frequency Driver, X336 Complementary Crossover Network utilizing full m derived ½ section crossovers, and two AT-37 Presence and Brilliance Controls.
GEORGIAN 4-Way System, Complete.
In Mahogany......Audiophile Net, $495
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AUDIO engineering society

Fifth Annual Convention - 1953

Largest program in history of the Society presents 29 papers.

Wednesday, October 14th

10:00 a.m. Annual Meeting of the Audio Engineering Society

Technical Session: Loudspeakers

Chairman. R. T. Bozak, The R. T. Bozak Co., Stamford, Conn.

10:30 a.m. DESIGN FACTORS IN HORN TYPE SPEAKERS
Daniel J. Plach, Senior Physicist, Jensen Manufacturing Company, Chicago, Illinois

A horn cannot be arbitrarily chosen for a given driver when best possible performance is required. The horn throat area, cutoff frequency, and flare parameter T must be properly related to the driver moving system constants. The advantage of the hyperbolic cosine horns over the exponential type is also discussed.

11:00 a.m. THE COMPOUND DIFFRACTION PROJECTOR
Louis S. Hoodwin, Engineer, Electro-Voice, Inc., Buchanan, Michigan

An inexpensive lightweight compound horn loudspeaker has been developed for high quality public address reproduction by coupling a re-entrant "woofer" horn and a small "tweeter" horn to opposite sides of a single diaphragm. The resulting unit has improved frequency response and polar distribution with lower distortion.

11:30 a.m. DESIGN OF A HIGH-FREQUENCY ELECTROSTATIC LOUDSPEAKER
C. E. Smiley, Livingston Electronic Corp., Livingston, New Jersey
Theodore Lindenberg, Pickering and Company, Inc., Oceanside, New York
Jerry B. Minter, Measurements Corp., Boonton, N. J.

This paper will describe the design features of an effective high-frequency speaker "tweeter." A simple circuit will be described for driving this loudspeaker to produce uniform sound pressure over an extended high-frequency range.

Technical Session: Audio System Design

Chairman: W. O. Summerlin, President, Pulse Techniques, Inc., West Englewood, N. J.

2:00 p.m. PHYSIO-PSYCHOLOGICAL FACTORS IN HIGH-FIDELITY REPRODUCTION
Louis A. de Rosa, Laboratory Head, Federal Telecommunication Laboratories, Nutley, New Jersey

The design of equipment for high-fidelity reproduction and for proper stereophonic effects may tolerate reasonable amounts of distortion. On the other hand, certain types of distortion are particularly annoying to the ear. The objectionable distortions are those which indicate the presence of new sources of stimuli. Information theory, physiology, and anthropology combine in directing the design of high-fidelity systems for maximum effectiveness.

2:40 p.m. CBS TELEVISION CITY AUDIO FACILITIES
Howard A. Chinn, Chief Engineer; Robert B. Monroe, Senior Project Engineer; and Charles A. Palmquist, Project Engineer; CBS Television, New York

CBS Television recently inaugurated program service from its new Television City headquarters in Hollywood. This paper discusses the philosophy underlying the design of the Television City audio and communication facilities and describes the installation in this modern television broadcasting plant. Emphasis is placed on description of features that are new or novel.

3:20 p.m. NEW ADVANCES IN LANGUAGE TEACHING: THE GEORGETOWN UNIVERSITY PROJECT
Morris Lewis Groder, Chief Production Engineer, Electrical and Physical Instrument Corp., Long Island City, New York

In recent years, electronic devices have played an ever widening role in the field of education. Georgetown University pioneered in the use of the tape recorder, oscilloscope, and other audio and visual devices for language teaching and multilingual interpretation. This paper describes the project at the University's Institute of Languages and Linguistics, the technical equipment used, teaching methods, and unique techniques devised to solve educational problems.

4:00 p.m. SYSTEM DESIGN FOR MULTIPLE COPYING OF TAPE AND DISC PROGRAM MATERIAL
Robert Winston, Audio & Video Products, New York City

A description of new high speed tape copying, disc mastering, and associated recording studios will be presented in this paper.

Thursday, October 15th

Technical Session: Disc Reproduction

Chairman: Alfred Jorysz, Dev. Engineer Presto Recording Corp., Paramus, New Jersey

10:00 a.m. A NEW WIDE-RANGE PICKUP
John F. Wood, Senior Engineer, Electro-Voice, Inc., Buchanan, Michigan

A wide-range, amplitude-responsive phonograph pickup has been developed utilizing a barium titanate generating element. Response has been made flat to the AES characteristic within professional tolerances. Discussion of this project is preceded by a brief consideration of magnetic pickups and recording practice. Particular emphasis is given to the amplitude-velocity relationship, and to the advantages accrued by the use of the ceramic element.

10:30 a.m. SIGNIFICANCE OF INTERMODULATION OF HIGH FREQUENCIES IN AUDIO EQUIPMENT
Emory Cook, Cook Laboratories, Inc., Stamford, Conn.

Application to audio of the constant-difference frequency method (CCIF) of intermodulation measurement is discussed. Correlation between results obtained and listener acceptance; specific means of implementing the system to produce results of maximum significance; the "N—A Beam" technique.

11:00 a.m. EFFECT OF HIGH-FREQUENCY PRE-EMPHASIS ON GROOVE SHAPE
Jerry B. Minter, Chief Engineer, and Aldo R. Miccioli, Engineer, Measurements Corp., Boonton, New Jersey

A theoretical derivation of the recorded groove shape for lateral cut records will be presented together with the effects of pre-emphasis. Experimental confirmation of these results will be included in the paper.

11:30 a.m. AN ANALYTICAL APPROACH TO PHONOGRAPH PICKUP DESIGN
Walter O. Stanton, President, Pickering and Company, Inc., Oceanside, New York

A qualitative examination of the fundamental relationships which exist between the mechanical elements in a phonograph pickup. The purpose of the paper is to derive basic equations, by a study of the dynamic tracking problem, which may be used in the design of pickups.

Technical Session: New Developments

Chairman: Sol Heller, Managing Editor, *Technician*, Caldwell-Clements, Inc., New York City

2:00 p.m. NEW DEVELOPMENTS AND APPLICATIONS OF PRINTED CIRCUITS
Arthur W. Kelly, Jr., Applications Engineer, Photocircuits Corp., Glen Cove, New York

The pros and cons of the latest manufacturing methods will be discussed briefly. This will be followed by a summary of the latest achievements in etched circuit techniques including examples, samples, and explanations of applications.

2:30 p.m. NEW BUSINESS OFFICE DICTATING MACHINE WITH MAGNETIC TAPE AS A RECORDING MEDIUM
Samuel J. Hyman, Chief Engineer, Permoflux Corporation, Chicago, Illinois

The development of magazine-loaded tape with standard reels has permitted flexible dictating machine design, featuring rapid start and stop as well as exceptional fidelity of reproduction. Several novel mechanical features and some unusual applications will be described in this paper.

3:00 p.m. A NEW APPROACH TO PROFESSIONAL MAGNETIC RECORDING EQUIPMENT
John W. Hines, Sales Manager, Magnecord, Inc., Chicago, Illinois

This paper will describe a new development in the field of professional magnetic recorders. This new recorder features several new and novel operating features.

3:30 p.m. ON-STAGE SELECTIVE SOUND RE-INFORCEMENT SYSTEM
Richard Edmondson, Engineering Dept., National Broadcasting Company, New York.

The required mobility of performers over increasingly large stage areas in television introduces problems not only of sound pick-up but also of sound re-inforcement to the stage and the creation of favorable acoustical environments for the actors.

The need for a special system to feed audience reaction, music, sound effects, and selected cast microphones to various parts of the stage, and as well as to create "natural" acoustics for the actors will be discussed. A system designed for this purpose and used in the NBC Center Theatre will be described.

4:00 p.m. SOME NOTES ON PROBLEMS ENCOUNTERED IN THE USE OF THE STANDARD REFERENCE TAPE
Frank Radocy, Director of Production Control, Audio Devices, Inc.

1. A description of the reference tape method as used in the Interim Federal Specification WP-61A (Navy Ships).
2. Observation on the changes in performance characteristics of the Standard Reference Tape resulting from physical changes due to repeated playing.
3. Variations in the Standard Reference Tape performance resulting from the replacement of magnetic record-reproduce heads.

4:30 p.m. A NEW TRANSFORMERLESS AUDIO AMPLIFIER CIRCUIT
Kerim Onder, Engineer in Charge, Circuit Research Laboratory, 617 W. 113th St., New York 25, N. Y.

This paper will describe a new transformerless amplifier with low-impedance output and no d. c. through the loudspeaker voice coil. The amplifier will be demonstrated.

7:30 p.m. Annual Banquet, Main Ballroom.

Friday, October 16th

Technical Session: Amplifier Circuit Design

Chairman: Lincoln Walsh, Chief Engineer, Walsh Engineering Co., Elizabeth, N. J.

10:00 a.m. A NEW 30-WATT POWER AMPLIFIER

Frank McIntosh, President, and Sidney Corderman, Chief Engineer, McIntosh Laboratories, Binghamton, New York

The McIntosh unity coupled output circuit is used in a new 30-watt amplifier. Resistance capacitance coupling is employed up to the output stage eliminating the driver transformer heretofore required. The amplifier offers extremely low harmonic and intermodulation distortion, flat frequency response, good transient response, and low noise level.

10:30 a.m. CONSIDERATIONS OF HIGH-QUALITY PREAMPLIFIER DESIGN

Martin V. Kiebert, Jr., Hasbrouck Heights, New Jersey, Consultant to Fairchild Recording Equipment Corp.

A new preamplifier design will be described which is scheduled for production in the near future. This preamplifier contains several novel features and provides flexible arrangement of controls.

11:00 a.m. AUDIO AUTOMATIC VOLUME CONTROL SYSTEMS

Frank W. Roberts, Director of Engineering & Research, and Robert C. Curtis, Chief Electronic Development Engineer, Dictaphone Corp., Bridgeport, Conn.

Audio automatic volume control systems used in a variety of applications fall into two general categories: compressors and limiters. Operate times should be short without introducing "thump" in the signal. Methods of control and "thump" cancellation are discussed. Both forward and backward acting circuits are shown and compared from performance and cost standpoints. Measurement techniques are described.

11:30 a.m. THE PHILOSOPHY OF AMPLIFIER EQUALIZATION

H. H. Scott, Hermon Hosmer Scott, Inc., Cambridge, Mass.

Modern high-fidelity amplifiers include equalizing circuits to cope with the wide variety of recording curves which have been used. In the design of such circuits, some reasonable compromise must be reached between flexibility—which often implies complexity—and convenience of operation. In this respect, the designer has had to meet conflicting demands from customers, to provide a variety of curve shapes matching closely a number of the desired playback characteristics, while at the same time keeping the control as simple as possible for the non-technical music lover. Current practice includes at least four solutions to the problem, each with its attendant advantages and disadvantages. The writer has been concerned with the design and manufacture of all four types, and will discuss the various design and operating factors involved for each type.

Technical Session: Home Music Systems

Chairman: Charles J. Fowler, Editor, *High Fidelity*, Great Barrington, Mass.

2:00 p.m. DECORATING THE HOME WITH MUSIC

Russell J. Tinkham, Manager Audio Sales Ampex Electric Corp., Redwood City, California

Music in the Home should be considered as much a part of interior decor as decorative fabrics, colors, and furnishings. The development of new recording and reproducing techniques make possible home music that reflects the character of the home owner. Just as music relieves tension in busy factories, offices, and stores, it can be used to soothe the fevered brow of a homemaker.

2:30 p.m. A COMPOSITE RECORDING SYSTEM FOR STUDIO OR HI-FI APPLICATIONS

Oliver Read, Editor, *Radio & Television News*

The audio engineer or the professionally-minded audio enthusiast can increase the versatility of hi-fi components by using broadcast techniques. A composite system is described wherein facilities are provided for both monaural and binaural recording, playback, and dubbing of tapes and discs with full monitoring and other features.

3:00 p.m. ENHANCING THE LISTENING QUALITIES OF HIGHLY DAMPED SMALL ROOMS AND STUDIOS

Paul Weathers, Weathers Industries, Barrington, N. J.

If the apparent size of the listening room can be artifically enlarged and the reverberation controlled to simulate the characteristics of a perfect auditorium for the type of music reproduced, the over-all results would be:

1. Spatial effect of a large room.
2. More apparent loudness without being more audible outside the room.
3. Reduction of objectionable distortion and noise.

This paper describes systems for producing controlled delays and repetition of delays.

3:30 p.m. AUDIO AND INTERIOR DECOR

Jeff Markell, New York City

This paper will consider some of the factors necessary to properly integrate audio equipment into the decor of a room.

4:00 p.m. A PRELIMINARY REPORT OF GROUP LISTENER REACTIONS TO BINAURAL SOUND REPRODUCTION

Harold T. Sherman, Sherman Studio, Carnegie Hall, New York

Multiple channel sound reproduction provides better realism than does our single monaural channel. A simple two-channel binaural system will allow the listener to assimilate more information through better definition and more natural loudness differences. Microphone placement will be discussed and related to group listener auditory reactions.

Saturday, October 17th

Technical Session: Multichannel Sound Reproduction

Chairman: William H. Offenhauser, Jr., New Canaan, Connecticut

10:00 a.m. STEREOPHONIC REALISM

Colonel Richard H. Ranger, Rangertone, Inc., Newark, New Jersey

Appropriate coordination between intensity and timing is essential for stereophonic realism. Different handling is required for music, speech, and localized sounds. Clean cut original recordings, mixed appropriately to a minimum of magnetic channels accomplishes the realism.

10:30 a.m. A STEREODYNAMIC MULTI-CHANNEL AMPLIFIER OF NEW CIRCUIT DESIGN FOR SINGLE OR BINAURAL INPUT

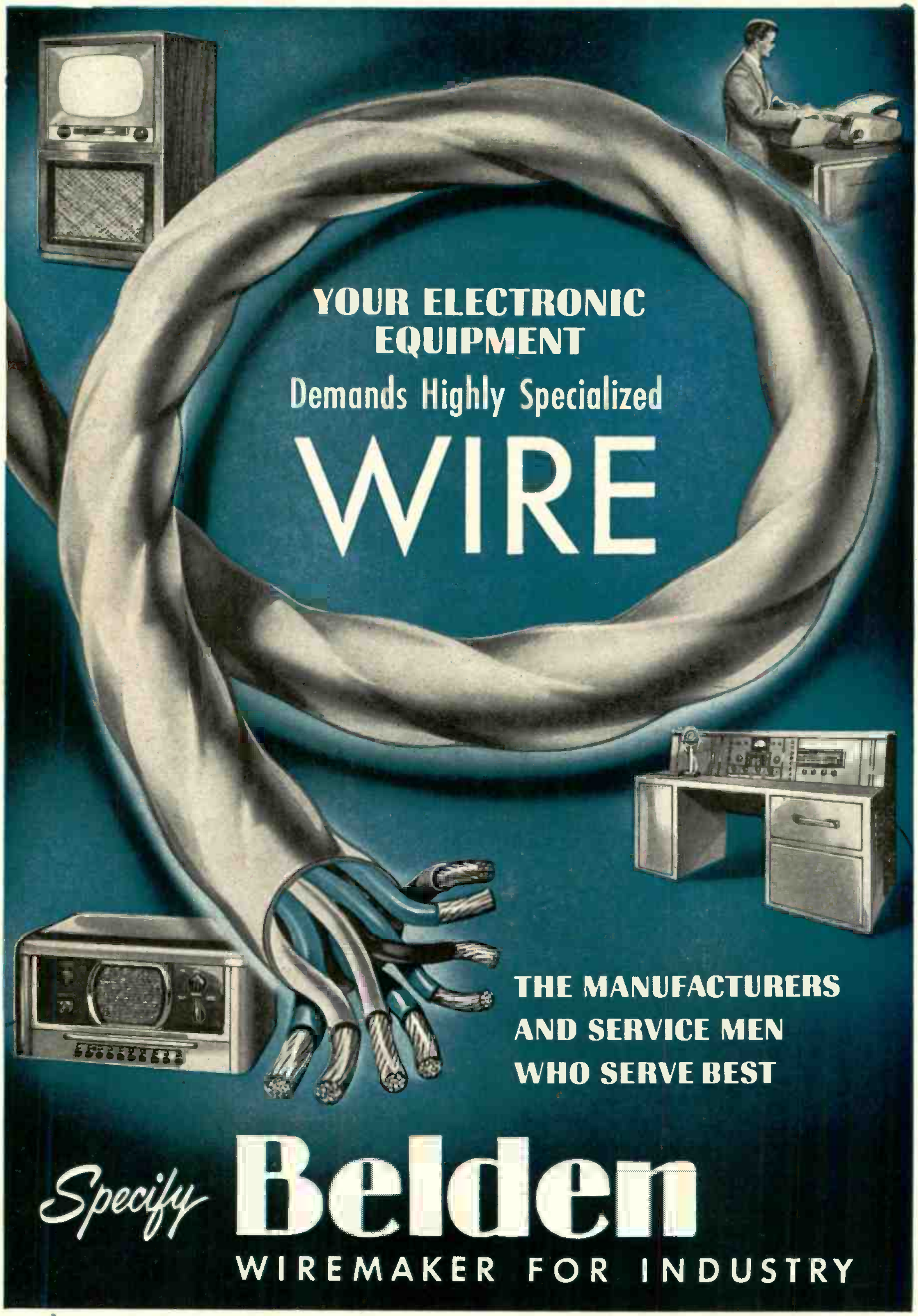
John Nigro, Madison Radio Sound, Madison, New Jersey

A multichannel stereodynamic amplifier for single or binaural input. A further development of a unique system of amplification, using dynamic control stages and an integrating third channel to effect greatly increased illusion of spatial distribution in reproduction of both single and binaural source.

11:00 a.m. MULTICHANNEL SOUND REPRODUCTION

Walter T. Selsted, Chief Engineer, Ampex Corp., Redwood City, California

The system described is typical of many such systems which are to be installed in the nation's theatres in the very near future. The considerations of power amplifier requirements, speaker characteristics, and power capabilities are among the many aspects of this problem which are covered in the paper. In this paper the input signal is supplied by magnetic reproducing equipment to be described in detail.


YOUR ELECTRONIC EQUIPMENT
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WIREMAKER FOR INDUSTRY

EDWARD TATNALL CANBY*

Rome, Italy

THIS DEPARTMENT has done some fair verbal wandering in its six-and-some years, but this is the first summer it has travelled—and travelling has done something to it. Maybe it's the heat, which is placidly anchored hereabouts in the high 90's (translating from the local centigrade) day after day, nor has there been a vestige of cloud in this crazy blue sky for almost three weeks. More likely, it's the European climate of human beings, which for these few months has given me the strangest and most interesting feelings about Audio and Records and America—so absorbing that I can't help but write for you what happens to be uppermost in my slightly feverish mind. It'll all have a good deal to do with our home business of selling records (lots of them made in Europe) and improving Audio, in the long run.

Leisure

There is such a strange mixture on this continent of fatalistic leisure and hysterical excitement, in any occupation you can think of. Things are done in the most ingenious ways, with utmost and direct simplicity in some areas and the utmost in complications in others. The Romans, as I write this, are tearing up the asphalt outside my hotel with an air drill. They've been at it ever since we got here and it looks as though by the end of the month they might get up to the corner, 20 feet away. Meanwhile, the most ingenious detours are made for the trolley busses to get around the mess. Everybody stops to watch and the workmen stop to watch too, or get lyrically eloquent in their operatic-tenor voices about minor matters like picking up a shovel and putting it down again. And they take three full hours off for lunch. Nevertheless, every one of Rome's thousands of streets is paved, and well paved. Things do get done, eventually, and when they are within the traditional commonsense base-area of daily living, they are done well and comfortably.

It's only when the Europeans try to ape American "luxury" that things go haywire. Like the shower I took last night: it poured and was hot and the room was neatly tiled in modern U.S. style—but there wasn't any drain. The water was supposed to plop into a basin about two feet square in the middle, which it did, if you didn't stand under it. Otherwise, it simply sprayed all over the floor. No curtain. Moreover, the shower is charged for, extra, and the maid practically escorts you under it. Or take the GE fluorescent shaving lamp which undoubtedly adds 20 per cent to my hotel bill; it goes on and off and flickers unbearably in the slow-cycle current. Or automatic elevator, which has three doors and stops six inches above the ground floor. Fix it? They just shrug their shoulders. To an Italian, that's the sort of thing that fancy machinery is bound to do and they aren't too worried about it. Why bother; it's only one step up. . . .

But, lest you think that this familiar story is my only one, let me quickly mention the other side. It is true that American-style gadget living (and this includes both phonograph records and the audio equipment to play them) is painfully expensive here and for most Europeans is plain out of the question. Even ordinary clothes are expensive enough. I priced a pair of Polaroid sun glasses today—$12, with brown plastic frames. In terms of the local incomes that might be $40 to you and me. Cameras, records, automobiles, every sort of "aid to modern living" costs that much. It's astonishing that so much is sold, even so. Yes, they can't afford gadgetry here. Only a few Europeans can indulge in record collecting and, outside of England, a microscopic number can be counted in the practicing hi-fi cult.

Newness

But the more important point is not the cost—but the fact that Europeans really don't take all these things very seriously. They manage to lead very pleasant lives, on the whole, without them. They use practical makeshifts, or they use traditional methods and old fashioned products—toilets, trains, washbasins, even records—that have long since proved their usefulness. Newness means very little, and in no time at all any reasonably sensitive American, as I hope I am, begins to feel that this is right and reasonable and proper. And sometimes even highly desirable. Indeed, the whole audio world (not to mention the current atomic explosions over 3-D, binaural, and what-not), my very profession itself, strikes me, here in Europe, as just a bit improbable. As improbable—here—as, say, at home the manufacture of gold plated Cadillacs and automatic toilet paper. (The latter was once described to me. I'll omit the details.)

Yes, I set off to Europe with the idea of doing some fine audio investigating en route, to find out what was going on over here in this country and that, as to records and as to machines. But it has turned out otherwise. I didn't know, somehow, that when I got here the reality of Europe itself would be so overwhelming, that audio, phonographs and all the rest would somehow fade into the background. The fact that they did, and to such an extent is, I think, very significant, for myself and for all of us, since, after all, I'm one of the more ardent protagonists for the art of recording and playing-back, and undoubtedly will be again—on my return to the U. S., shortly.

I'd better say hastily that this is no attempt to discredit either phonograph records or audio in any form. Somehow, though, I've got to get over to you what strikes me so strongly here, while I'm in Europe, as a different and reasonable way of life. We should see ourselves as others see us, once in awhile.

Here, in Rome, and in Paris and Switzerland and Florence and other spots I've stopped at, are the people who might, or might not, buy our exports, our LP records, our audio amplifiers—our life itself. And here are the people who are sending us, now and then, some of their best new products, in audio as well as elsewhere. We're becoming aware of Europe in a strictly business manner, far more than we used to be. And we'll find in them what I am finding—a remarkable sense for the basic things of life and a strong tendency to avoid unnecessary gadgetry, novelty, spectacularness, in favor of tried-and-true and workable things; an equally strong tendency to take things slowly, with endless good natured complications in procedure. Forms, forms, forms! Why? Because nobody sees any reason to save time by *not* filling out forms.

Buildings and Trains . . .

Thus building construction, street repairs, electric wiring—all such things—are done with an implacable complexity and slowness. Watching the rebuilding of a

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

war-bombed bridge across the Arno in Florence (they've spent two weeks already boring a single hole in the old concrete foundations) I couldn't help feeling that time would move snail-like for generations before any tangible progress was made—yet in the end I knew for a certainty that the work would be done, and well done too. It was men of this sort who built the great Gothic cathedrals, working on for centuries in the same slow, good-humored, complicated way.

There's a sureness and an infinite patience in this slowness that at first drives one to exasperation, then to admiration. I saw a dozen men moving a small mountain of gravel a few hundred yards to make a huge fill, toiling in the tropical sun with picks and shovels and hand-pushed carts on rails. Roman slaves! The work already done looked like that of a dozen steam-shovels and trucks; it must have taken years, and would take many more—to make room, finally, for some minor restaurant or filling station on the new ground. How futile, in the face of such serene patience, to say that we in the U. S. would do the job in a couple of days!

My fast express from Naples to Rome the other night had a hot box, right under my seat. Smoke poured up, we stopped and everybody immediately hopped out on the right of way to look at the interesting sight, with philosophical pleasure. The conductors gabbled to the engineers and pointed, but did nothing, the passengers took the opportunity to smoke a leisurely cigarette and enjoy the cool night breeze—right in the middle of the express track. Nobody seemed a bit disturbed, everybody talked, and not a thing was done for fifteen or twenty minutes, during which time the entire rail communication between Rome and Naples was completely blocked. After awhile, when the cigarettes were done and the pleasant intermission over, we all got back in, moved to another car, and the offending one was hauled along, smoke and all, at half speed into Rome. No excitement—for, again, this is the way with machinery, one feels. Why get excited?

As a matter of fact, this and a couple of other train trips here have been the most thoroughly enjoyable I've ever had. What blissful unawareness of air conditioning, and what an advantage! The trains are electric—that was a fundamental advance that really mattered—and the ancient and very comfortable cars have big, low, panorama windows that slide down to knee level. In this warm, dry climate every window in the train was wide open. Standing in the corridor at one side (compartments on the other) we were practically outdoors and indeed whenever the train went slower than 80 kilometers half the heads in the train were stuck outside in the fresh air. I took pictures out of one window of a friend at another. It was all extremely simple and utterly lovely, with the most delightful grapes-mountains-and-olives scenery sliding past, brief stops at dozens of stations (this was a *direttissimo*, a very, very direct train, and merely stopped at half the stations instead of all of them) where bottles of wine, orange soda, ice cream sticks could be bought by leaning out of the low windows. So liveable, so comfortable, so *practical*. No matter that in the tunnels the noise was deafening, no matter that we didn't dare go to the dining car and leave our baggage unguarded. (Our fault for having silly gadgets like expensive cameras and light meters and nylon shirts.)

We've got ourselves so modernized at home that we can't lean out of train windows any more and take in the countryside. More's the pity.

Autos and Scooters . . .

So with other matters. I was amazed to find, with my keen eye for automobiles, that after a week or so on the continent I no longer noticed the 25-year-old and the 15-year-old cars as out of date. The plain fact is that they really aren't—they still run well, since they were built well in the first place and are well cared for as permanent valuables, now as always. No jalopies hereabouts. Even the new cars don't necessarily look new in shape. The medium Fiat imitates an early Kaiser and other models copy the U. S. in miniature, after a fashion; but the outstanding front-wheel-drive French Citroën, existing in hundreds of thousands in France and more revolutionary than anything we have, has lines not unlike the 1933–34 Ford, flattened and widened. Ancient American cars take on a reasonable and permanent dignity here—a 1940 Chevvy or 1935 Ford looks as important and as desirable as the newest model. Cars are small because it's convenient and economical to have them small, which is a first-class reason. Here again, flashy "newness' is singularly unimportant, even in the relatively dynamic and modern auto industry of Europe.

Another Citroën, the cheapest model, is the simple and practical realization of what Crosley simply could not do in the U. S. It is a plain, flat-sided box of a car, crudely streamlined with a folding canvas roof and bucket seats, plus a species of motorcycle engine, and it comes in one color, dull brown-gray; but it is the poor man's auto par excellence and will take you anywhere. Moreover, it's full-sized, as cars go here—it gives the maximum room, convenience, and economy that engineering can devise, and don't think that European engineers aren't as good as ours. It isn't the engineering competence, it's the economy, but even more, the attitude! No Frenchman is going to be deterred by a hideous car, if it will serve him well.

But who wants a car? Over here, one realizes, to put it simply, their disadvantages. Cars are luxuries to begin with, but again, one feels that they are often ostentatiously cumbersome. I am aware here, every day, that I can afford things that Europeans can't, and this in itself can be unpleasant in daily life; there is envy and some dislike, only reasonable, which one must face out as well as one can. No use explaining that you really aren't wealthy.

I merely bought a car in England, to drive freely on the continent; but, inside it, I'm automatically the most dismal sort of plutocrat and moreover, I suffer inconveniences no end. My Austin is a big, bloated, over-fat expensive foreign car here in Italy and the funny thing is that *I* feel it so, and see it so, and can't help it. It is out of place, it is in doubtful taste, and in the most practical sense it is unnecessary and unsuited to the European way of life; it won't take sharp corners easily and most of this country's roads I've hit are hairpin-ridden; it fills two thirds of the street and I have to back twice to get it around two corners into my garage in Florence. Neither pedestrians nor bicycles nor motorcycles will get out of my way and I'm often reduced to moving at a humble crawl while two carefree and unencumbered souls carry on a conversation walking in front of my fender. It takes a desperate amount of energy, physical and nervous, to drive. And it's deadly hot in the sun.

How much easier, then, to own what everybody owns here, a Vespa or equivalent. The Vespa is a marvellous three-speeded scooter-bike which infests continental roads by the millions. Vespas (also a couple of million flea-powered gas-engine bicycles) can be parked on a dime (60 Lira) or in dozens of "parking lots" which are simply ground-floor rooms in houses. You just wheel your machine indoors and sometimes they actually hang it up on the wall. But Vespas will do 45 or 50 and they'll climb anything from a side of a house to an Alp. You step onto them and you can get off by walking off. A pretty and common sight is the family Vespa—Papa in front, baby in the middle and Mama serenely whizzing along sitting side-saddle in back, her elegant legs swinging luxuriously in the air. Women ride them as casually as ours drive their Chryslers.

Perhaps you can understand why I left my great road-hog of an Austin in Florence, eating its head off in a garage, and came to Rome by train!

I could go on and on about this common-sense European approach to simple conveniences and the complementary lack of understanding for our American ways. The whole things is so fundamental, so hugely, immovably *existing,* that one gains a rather terrifying appreciation of the difficulties we all face in the so-called "West" in understanding each other. Yes, you can buy Lux and chlorophyll toothpaste and you can see 3-D and listen to Gershwin almost anywhere in Europe, and the roads are lined with Shell and Esso and Mobilgas stations and other European equivalents; life on the surface is much more like ours than most readers who haven't been here can imagine. If you're a real tourist and get yourself taken around by one of those planned-tour organizations, or go "sponsored," you'll not see much else. But just try it on your own awhile.

The English Channel is, at its narrower parts, only 20-odd miles wide at a guess. But it took just 28 hours to get me and my car across it—and everybody was as nice and cooperative as you can imagine. Car ferry? No such simple gadget as that. We had to be on hand at 7:30 a.m. in the morning to fill up forms, show passports, receipts and a barrel of other paper—I'd got reservations two days earlier, on advice. The cars were stowed by crane, one by one, in the very bottom hold of a special cargo boat; a second boat left, after four hours' wait, at 11:30 with the passengers. Most ingenious, too, the fancy adjustable clamps by which the cranes could whisk any size car 50 feet up in the air by its four wheels and down 100 feet into the ship's innards (where a good dozen men rushed about pushing the cars into distant and inaccessible corners). Rather terrifying to watch, especially when your own car sailed through the air overhead. On the other side, it took a half hour in a cloudburst to line up the passengers and get their landing slips stammped, then more time to have passports checked. (There wasn't any customs. The Europeans know when to stop and we haven't so much as had a bag looked at yet this summer.) Another two hours' waiting for the cars to be unloaded, one by one, from the cargo hold of the other ship—and we were off. A simple car ferry would have done the job in three hours or less. But, as I say, everyone was most coöperative and pleasant; you couldn't really get up heat enough to complain, the whole operation was so neatly, beautifully managed! The food on the passenger ship was excellent, too, and we met some very fine people—altogether a rather pleasant if strenuous twenty miles' worth of travelling.

But note well that, if you want to pay for it, you can have your car *flown* across in a double-deck box-car plane on regular schedule; you fly in the upper part and the car downstairs. Haven't heard of that yet, back home.

I haven't seen a toilet newer than 75 years young yet (except in the American Express in Paris) but, if I may put it delicately, I haven't suffered any. Instead of those elaborate electric table grill affairs that we give people at home for wedding presents—infra-red, bake, broil and the rest—they have a much simpler and more practical device here that struck me as truly European—a second-helping heater. There's one on each table, in Switzerland; it's a simple plastic or ceramic box-tray with perforated top and two candles burning inside. Put your serving plate on it and the food stays exactly the right temperature for the second helping—no thermostats needed, and it costs even less than "one cent a day."

Tear it down?

A last example—trolley cars. Public transportation is extensive in every city since autos aren't much used. Trolley cars—"trams"—are everywhere, along with the newer trolley buses, filobus in Italian. No fancy streamlining; most trams are four-wheelers that can get through the old, narrow streets with ease. To cope with larger populations they've simply added trailers, or as in Rome and Genoa, built on extra pieces of body to the old cars; one type has a front car, a middle one suspended in space without wheels and a rear trailer. Very odd looking and probably overloads the original traction motors, but I haven't seen any breakdowns and the fare in Rome is about two cents. They can't afford many new cars here, but again, one feels they really don't consider it important to have them. I agree. Not for a higher fare, anway.

Indeed, unless you tear down the entire European collection of cities, with their six-foot streets, their hunched, piled-together masses of overlapping buildings, rebuilt and rebuilt for hundreds of years without ever a demolition complete and sweeping, short of war or Napoleon (he did it, in part)— unless you destroy this complex ancient European civilization itself, from whence we came, this way of life, so easily and unaffected carried on in its own environment, which builds the new on top of and inside and around and under the old, which keeps to the ancient and trustworthy ways of doing things as long as they continue to be convenient and practical for the moment, which is given to violent excitement in every argument, yet exists in the utmost and unfathomable leisure with time for everything—unless you tear down all this, destroy the towns, reeducate the people, break apart what has taken thousands of years to build up—you'll never find American gadgetry making much headway, in the large or the small, on this ancient bit of soil, until it has really proved itself in a slow, measured and sober manner.

Audio

There is, after all, an application here even for the phonograph industry. I've kept a travelling eye open for signs of audio and phono life and I've seen some interesting bits of engineering, too—I'll get to some in a later edition. Yes, there are buyers in Europe for phonograph records and even a microscopic few for audio products. But the stuff costs a painful fortune in terms of salaries and wages, and more important, it must exist—and sell—in the European way. Once more, I can't help but suggest that the phonograph, as an expensive device, and the record too, must sell strictly on its purely artistic, (i.e. *practical*) merits. Nobody is going to buy gadgetry here because it is new, the "latest," exciting.

I've seen LP records in windows, but they are almost without exception those which we have in our own windows at home. Recorded in Europe, lots of them, processed in the U. S. or in England, then sold to the Europeans (who recorded them, perhaps) as "imports." I wasn't surprised to find familiar labels—Urania, Westminster, Columbia, Decca (London), RCA and the rest, nor was it remarkable that most of the discs were yellowed and faded from long inaction, in a static show window. Show windows here are for tourists, and tourists don't buy records—not LP's, anyhow.

I've heard lots of radio—same old disc jockey programs, in each language, only minus the commercial—and I've listened to a Swiss console with a jukebox tone de luxe, a boom as big as an elephant and highs to 1000 cps.; but I've also heard the best small table radio I've ever listened to, truly high fidelity, with the finest voice quality I ever expect to experience. I've seen clumsy pickups and lots of ingenious new tiny ones, three speed. Don't think that the talent for designing isn't around—it certainly is.

But the economics and the atmosphere are agin it. The civilization is agin it. You'll have to tear down not only the cities but their power systems and their communications before audio has half a chance here. I've kept tabs on current as I've gone along: 120, 180, 250 volts, all are common, with plenty of flexibility. Cycles are nominally 50—plus or minus enough to send any phono motor on a wow spree. (There aren't any electric clocks.) Electricity is everywhere, even in the tiniest and most backward village. But it's not designed for musical purposes.

A European radio dial is a nightmare of what seem to be dozens of bands and whole paragraphs of microscopic print. They're courageous here—radio, after all, is a lot more than mere entertainment to people who have lived through the last war without other source of outside information—and the shop windows are full of portables down to the miniature size, every one equipped with the complete nightmare dial and costing the usual incredible fortune. When these people really want something they'll go to any end to get it.

And so I feel that, given a minimum of high-pressure salesmanship and a maximum of quiet, common-sense persuasion—also, given plenty, plenty of time—both the LP record and our improved audio equipment will grow to be greatly appreciated in every country that is available to us. We do, after all, have values to offer, thanks to our own technical advances, and in these last few years of our post-war prosperity we've shot ahead (with England, Denmark, Germany, not too far away from us) at a speed which is wholly typical of our wild and exciting way of living.

Let's not underestimate European intelligence, common sense and native ability—and let's take Europe in its own terms, whether for audio or for world politics.

DANNEMORA DUNGEON

(from page 52)

ordinary records through wide-range systems to turn up the volume to the pain-point or the distortion point, whichever comes first. Imagination signals that it cannot quite make the grade, pull out the throttle a little more, and maybe we'll get more clues. Many a harried housewife will be glad to know that after the first binaural blush is off, her daily stint of deafness will be only an evening memory. Daddy will play binaural at comfortable volume, and he will play the ordinary seldom if at all.

—Emory Cook,
Cook Laboratories,
Stamford, Conn.

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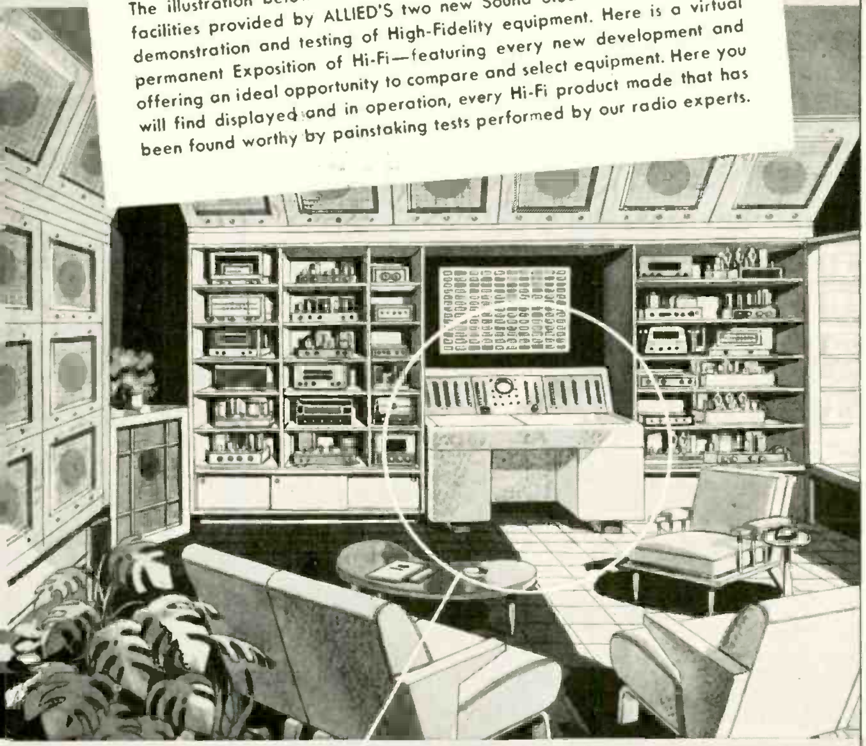

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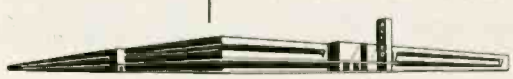

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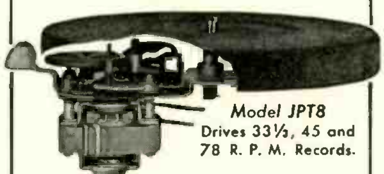

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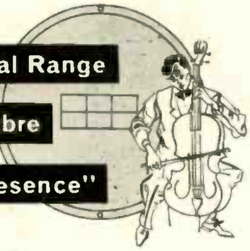

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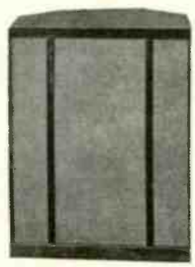

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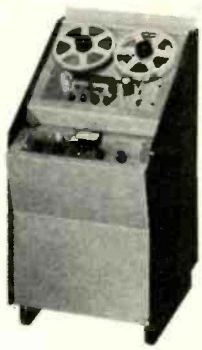

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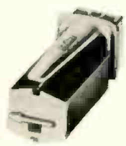

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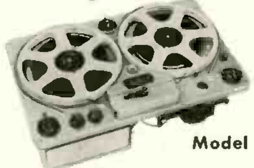

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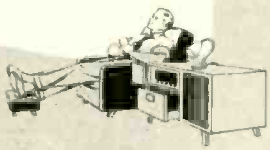

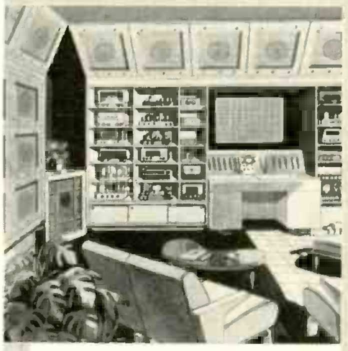

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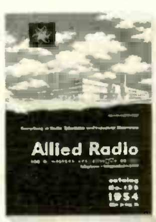

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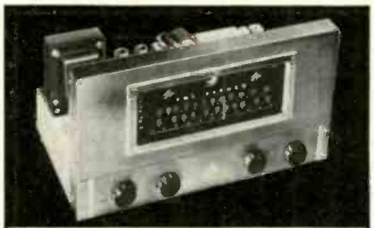

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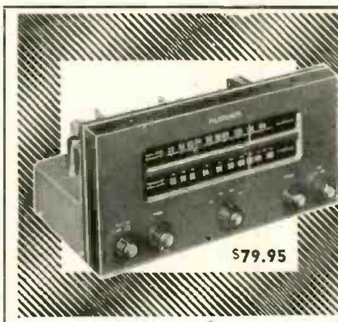

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only high fidelity portable unit using

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world's finest 3 speed record changer with the GE VARIABLE RELUCTANCE *magnetic cartridge*

When the cover is raised it combines with the speaker enclosure to provide a wide dispersal of sound usually associated with large, complex loudspeaker systems. Sturdy base (available at slight extra cost) converts the Dorset from a traveller to a chair-side home music system.

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- RECORD COMPENSATOR
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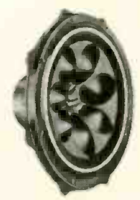

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With its wide background in all phases of professional quality sound, RCA has designed a complete selection of high-fidelity equipment that will satisfy the most critical music lover. All component units have been carefully intermatched for maximum performance, and the many possible combinations can be made to meet any individual listening needs.

Hear the thrilling extended-range reproduction of RCA'S new Intermatched systems in our studios today.

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Stromberg-Carlson

"CUSTOM FOUR HUNDRED" 25-WATT HIGH FIDELITY AMPLIFIER "AR-425"

This de luxe amplifier enables you to realize the full capabilities of the finest speakers. Frequency response—20-20,000 cps $\pm \frac{1}{2}$ db.

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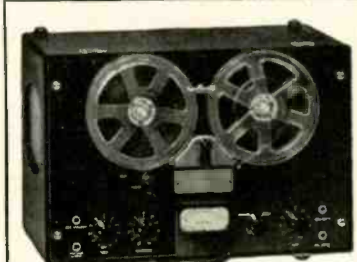

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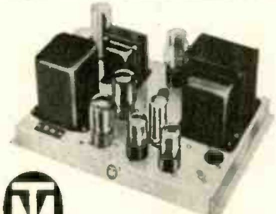
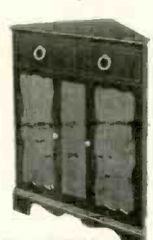


CONE SPEAKERS



ENCLOSURES

TWEETEERS

PROJECTORS

THE AUDIO FAIR—1953

Directory of Exhibitors

With more than 100 exhibitors readying their rooms for the fifth Audio Fair, every audio engineer, hobbyist, experimenter, and music lover in the New York area is straining at the ropes waiting for the opening day—October 14—and many more thousands will be coming from afar to visit the largest and most interesting event of the audio year.

The year 1953 has been the greatest—so far—in the history of high-quality sound reproduction, and the *high-fidelity* "craze" has hit with a considerable impact. And while there are many products labeled *high-fidelity* which do not honestly deserve such a label, there are still plenty of truly-high-quality amplifiers, speakers, tuners, and other components. The purpose of the Audio Fair is to give everyone an opportunity to see *and hear* what is new. The exhibitors listed below and on the following pages are those who had furnished the information by press time—undoubtedly several others will have made plans to exhibit before the opening day. Note the time and place—

When: October 14, 15, 16, and 17, 1953
Where: Hotel New Yorker, New York City

Registration on 5th, 6th, and 7th floors.

Exhibit Hours

Wednesday	11:00 a.m. to 9:00 p.m.
Thursday	10:00 a.m. to 6:00 p.m.
Friday	10:00 a.m. to 10:00 p.m.
Saturday	10:00 a.m. to 5:00 p.m.

ACRO PRODUCTS COMPANY 515

369 Shurs Lane, Philadelphia 28, Pa.
Products: Acrosound Ultra-Linear transformers, Acrosound Ultra-Linear amplifier circuits.

IN ATTENDANCE

David Hafler, Herbert I. Keroes, Gertrude Hafler, Harold P. Blumenstein

ALPHA WIRE CORPORATION 639

430 Broadway, New York 13, N. Y.
Products: Wire and cable.

IN ATTENDANCE

Peter Bercoe, Donald Rappaport, A. E. Bernardik, D. Litt, Howard B. Saltzman, Andrew Coy, Samuel Schaeffer, Nat Frost, Sidney Manners, Max Harts

ALTEC LANSING CORPORATION 619

161 Sixth Ave., New York 13, N. Y.
Products: High-fidelity home music equipment, consisting of AM-FM tuners, power amplifiers, remote preamplifiers, Duplex loudspeakers, and 820A corner speaker system.
Also will be shown other important sound products used in public address, such as microphones, amplifiers, loudspeakers and Peerless transformers for custom construction of high-quality amplifiers.

IN ATTENDANCE

A. A. Ward, C. S. Perkins, J. K. Hilliard, R. W. Kautzky, H. S. Morris, J. J. Connolly, W. H. Hazlett, Tom Gallatin, L. D. Netter, Jr., R. W. Griffiths, M. N. Wolf, A. E. Byers, R. E. Pierce

AMPEX ELECTRIC CORPORATION 542

934 Charter Street, Redwood City, Calif.
Products: Magnetic tape recorders and reproducers.

IN ATTENDANCE

Harrison Johnston, Jules Joslow, Russell J. Tinkham, Robert Sackman, Phillip N. Gundy, James A. Ford, Charles Wirth

AMPLIFIER CORP. OF AMERICA 622

398 Broadway, New York 13, N. Y.
Products: Magnetic tape recorders; amplifiers.

IN ATTENDANCE

N. M. Haynes, Clarence Westlake, R. Epstein, William Lutter, Max Ellis, Walter Bernadski, Frank Kosinski, Eileen Drasin, Tony Gillette, Harriet Marcus, Ernest Heller, Jerry Rosenthal

AMPRO CORPORATION 716

2835 N. Western Ave., Chicago 18, Ill.
Products: Tape recorders, magnetic-optical 16-mm projectors.

IN ATTENDANCE

Howard Marx, William Mullen, Howard Handwerg, Robert Saichek, C. Richard Smith

ANGLE GENNESEE CORPORATION 506

107 Norris Drive, Rochester, N. Y.
Products: Custom-built cabinets for hi-fi equipment—oak and mahogany.

IN ATTENDANCE

Charles E. Angle, Harold L. Charles, H. Wilder Clapp, James H. Brooks, L. P. Lucieer

ARROW ELECTRONICS, INC. 541

82 Cortlandt St., New York 7, N. Y.
Products: High-fidelity audio equipment

IN ATTENDANCE

Charles Ray, Fred Steiner, Oscar Kraut, Walter Berk, Jack Kufeld

ASCO SOUND CORPORATION 643

115 W. 45th St., New York 36, N. Y.
Products: Distributors of high-fidelity sound equipment; custom-built music systems for home, industry, schools, institutions, and professional studios; industrial speech reinforcement systems designed and installed. Custom-built furniture cabinets for sound equipment, wall units, special design units and restoration of existing units.

IN ATTENDANCE

Irving Greene, Ruth Gershon, Ozzie Reiter, Joseph Gshar, Gerry Macdonald

AUDAK COMPANY 629

500 Fifth Ave., New York 36, N. Y.
Products: Audio-electronic apparatus.

IN ATTENDANCE

Maximilian Weil, Al. Weberg, G. V. Sullivan, Peter Boch

AUDIO DEVICES, INC. 651

444 Madison Ave., New York 22, N. Y.
Products: Recording discs, AUDIODISCS* magnetic recording tape, AUDIOTAPE* magnetic recording film, AUDIOFILM* recording and playback styli, AUDIOPOINTS.*
* Trade Mark.

IN ATTENDANCE

William C. Speed, Roderick L. Hickey, Bryce Haynes, David S. Gibson, Herman Kornbrodt

AUDIO ENGINEERING SOCIETY 617

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

IN ATTENDANCE

Officers and Governors of the Society.

AUDIO EXCHANGE, INC. 735

159-19 Hillside Ave., Jamaica 32, N. Y.
Products: Audio and high-fidelity equipment.

IN ATTENDANCE

William Colbert, Miriam Colbert, John Colbert

AUDIO & VIDEO PRODUCTS CORPORATION 611-612-614-615

730 Fifth Ave., New York 19, N. Y.
Products: Magnetic tape equipment; tape recording accessories; custom installations; tape libraries; electronic components.

IN ATTENDANCE

Charles E. Rynd, Robert D. Winston, Kenneth B. Boothe, Philip Erhorn, Thomas J. Merson, Jerry Levy, Joseph F. Hards, Howard Lawrence

THE AUDIO FAIR 627

67 West 44th St., New York 36, N. Y.

IN ATTENDANCE

Harry N. Reizes, Jack N. Schneider, David Saltman, Claire Grosfeld, Harold Weisner

AVCO MANUFACTURING CORPORATION 706
Appliance and Electronics Division

1329 Arlington St., Cincinnati 25, Ohio.
Products: High-fidelity and remote control television displays.

IN ATTENDANCE

L. F. Cramer, J. M. Farrell, H. E. McCullough, R. K. White, C. F. McGraw

BEAM INSTRUMENTS CORPORATION 520-521

350 Fifth Ave., New York 1, N. Y.
Products: Tannoy Dual-concentric speakers and enclosures; acoustical Q.U.A.D. amplifiers and control units; Goodmans industrial and replacement speakers; sterling audio wires and cables; cossor portable oscilloscope.

IN ATTENDANCE

T. Robinson-Cox, J. S. Clark, T. R. Sheron, P. Walker, J. Alan Biggs, M. H. Fountain, R. W. Haviland, P. Livingstone, E. Judels, F. Keenan

BELL SOUND SYSTEMS, INC. 524

555 Marion Road, Columbus 7, Ohio
Products: High-fidelity amplifiers; tape recorder; disc recorders; speakers.

IN ATTENDANCE

F. W. Bell, S. C. Martin, H. H. Seay, Jr., W. E. Williams, E. D. Sisson

This brand new baseball glove, pre-oiled and deep-pocketed, needs no breaking in.

This new reel of SOUNDCRAFT Tape, Micro-Polished at the factory, needs no breaking in.

Now! a "Broken In" Tape

Exclusive SOUNDCRAFT Micro-Polished Tape Gives Stable High Frequency Response right from the start*

In the past, all *new* reels of Magnetic Recording Tape had surface irregularities and protuberances (oxide nodules) on the ferrous oxide surface. These irregularities and nodules caused imperfect head contact and a subsequent loss in high frequency response, *until the tape surface was worn smooth by the recording head.* This is the reason for the widespread professional practice of "breaking in" a new reel of tape. This is why engineers run new tape through the recorder a number of times *before recording,* wasting time and effort, and causing undue wear of the recording head.

ONLY SOUNDCRAFT TAPE IS MICRO-POLISHED

There is no break-in period needed with SOUNDCRAFT Tape. *Because all SOUNDCRAFT Tape is Micro-Polished.* This exclusive process pre-conditions SOUNDCRAFT Tape *before it leaves the plant.* Micro-Polishing subjects the ferrous oxide coating to high mechanical stresses. It produces a mirror-smooth tape surface. It achieves *immediate* stable high frequency response. And it allows new tape to be interspliced with tape that has already been used.

OTHER SOUNDCRAFT FEATURES

Not only is Soundcraft Recording Tape Micro-Polished, but it is also endowed with the following features developed by Soundcraft research engineers.

PRE-COATING to insure better adhesion, prevent curling and cupping —

DRY LUBRICATION to eliminate squeals —

SPLICE-FREE guarantee on all 1200' and 2500' reels.

Why settle for less than the best?

Next time, insist on Soundcraft Recording Tape.

It's Micro-Polished!

REEVES
SOUNDCRAFT
CORP.
10 East 52nd St., Dept. B-10, N. Y. 22, N. Y.

*Pat. Applied For.

BERLANT ASSOCIATES 532

4917 W. Jefferson Blvd., Los Angeles 16, Calif.
Products: Concertone magnetic tape recorders and accessories.

IN ATTENDANCE

Emmanuel Berlant, Harlan Thompson, Gertrude Sands, Paul Letl, Richard Hoskin

DAVID BOGEN CO. INC. 632

29 Ninth Ave., New York 14, N. Y.
Products: High-fidelity amplifiers; AM-FM tuners; AM tuners; FM tuners; AM-FM receivers; equalizers; loudness contour control; transcription players; radio console cabinets; intercoms.

IN ATTENDANCE

Lester H. Bogen, Mortimer S. Sumberg, David E. Pear, A. M. Zuckerman, Vinton K. Ulrich

THE R. T. BOZAK COMPANY 648

114 Manhattan St., Stamford, Conn.
Products: High-quality loudspeakers.

IN ATTENDANCE

R. T. Bozak, L. F. Bozak, C. F. Bogart

BRITISH INDUSTRIES CORP. 650-652-653

164 Duane St., New York 13, N. Y.
Products: Garrard record changers and phono equipment; Leak "point-one" amplifiers; Wharfedale speakers; RJ audio products; KT66 tubes; and other high-quality audio components.

IN ATTENDANCE

Leonard Carduner, Franklin S. Hoffman, William Carduner, Eugene Carduner, Harold J. Leak, G. A. Briggs, Morton Lee

BROCINER ELECTRONICS LABORATORY 523

1546 Second Ave., New York 28, N. Y.
Products: Model 4 corner horn; Transcendent 3-way corner reproducer; model A100 preamplifier-equalizer; model CA2 control amplifier; model UL-1 power amplifier; and new products now under development.

IN ATTENDANCE

Victor Brociner, A. Stewart Hegeman

BROOK ELECTRONICS, INC. 511

34 DeHart Place, Elizabeth 2, N. J.
Products: Brook high-quality audio amplifiers.

IN ATTENDANCE

Lincoln Walsh, Max Baume, Ann F. Hall

BROWNING LABORATORIES, INC. 645

750 Main St., Winchester, Mass.
Products: FM & AM-FM tuners.

IN ATTENDANCE

G. H. Browning, R. L. Purrington, R. E. Lonnberg, S. S. Egert, Jack Fields, J. Mandel

CONRAC, INC. 721

19217 E. Foothill Blvd., Glendora, Calif.
Products: Fleetwood television chassis.

IN ATTENDANCE

W. I. Moreland, R. M. Alston

COOK LABORATORIES, INC. 649

Route 2, Stamford, Conn.
Products: Cook Laboratories "Sounds of Our Times" recordings; test recordings; binaural pre-amplifier.

IN ATTENDANCE

Emory Cook, Bob Bollard, Michael Adrian

COWAN PUBLISHING CORP. 627

67 West 44th St., New York 36, N. Y.
Products: Radio-Television Service Dealer; CQ—The Radio Amateurs' Journal; Video Speed Servicing Systems; Radio Amateurs' Mobile Handbook.

IN ATTENDANCE

Sanford R. Cowan, Sanford L. Cahn, Harry N. Reizes, Jack N. Schneider, Oliver P. Ferrell, Samuel L. Marshall, Harold Weisner

DAYSTROM ELECTRIC CORPORATION 703
Crestwood Recorder Division

837 Main St., Poughkeepsie, New York
Products: Magnetic tape recorders.

IN ATTENDANCE

J. F. Brehm, C. R. Frost, F. L. Randell, H. H. Hanlon

DuKANE CORPORATION 507

St. Charles, Illinois
Products: DuKane "True-Fidelity" tape recorders.

IN ATTENDANCE

R. L. Shoemaker, R. W. Wilson, H. M. Jaffe, J. N. Cooper

DUOTONE COMPANY, INC. 705

Locust Street, Keyport, New Jersey
Products: Hi-fidelity speakers, microphones, diamond phonograph needles, electro-wipe cloth, recording tape, adaptors, recording blanks, recording heads.

IN ATTENDANCE

Stephen Nester, Mrs. Stephen Nester, Benjamin Rosenberg, Lee Rocke, Tom Marciano

ELECTRO-VOICE, INC. 626

Cecil & Carroll Streets, Buchanan, Michigan
Products: Standard Ultra-Linear high-fidelity ceramic cartridges; crystal and ceramic phono-pickups and cartridges; broadcast, public address, recording, communications amateur, and special purpose microphones; high-fidelity, full-range loudspeakers; low-, mid-, high-, and super-high-frequency drivers; cellular and diffraction horns; crossover networks; speaker enclosures; broadband television boosters and distribution systems; public address loudspeakers; equipment consoles; compound diffraction projectors and accessories; UHF converters.

IN ATTENDANCE

Albert Kahn, Lawrence LeKashman, A. M. Wiggins, Howard Durbin, Howard Souther, Eugene Carduner, S. Fleischman, S. Holt

ESPEY MANUFACTURING CO., INC. 634-635

409 Grand Ave., Englewood, N. J.
Products: High-fidelity AM-FM receivers, tuners, and amplifiers.

IN ATTENDANCE

Nathan Pinsley, Sol Pinsley, Edward Robinson, Paul Ash, Dave Levine, Sylvan A. Wolin, Bert Kohl

FAIRCHILD RECORDING EQUIPMENT CORP. 526

154th St. & 7th Ave., Whitestone, N. Y.
Products: Pickup cartridges, transcription arms, transcription tables, preamplifier equalizers, power amplifiers, input transformers.

IN ATTENDANCE

Jay H. Quinn, Ray F. Crews, O. L. Seda, C. V. Kettering, Robert Marshall

FERRANTI ELECTRIC, INC. 718

30 Rockefeller Plaza, New York 20, N. Y.
Products: Pickups, Transformers.

IN ATTENDANCE

R. H. Davies, M. J. Pope, W. W. Weiss, M. Dellerson

FISHER RADIO CORP. 529

45–41 Van Dam St., Long Island City 1, N. Y.
Products: The Fisher model 50-A amplifier, model 50-C master audio control, and model 50-R FM-AM tuner.

IN ATTENDANCE

Avery R. Fisher	Henry Mandler
Bennett Arons	George Meyers
George Maerkle	Leonard Feldman
James J. Parks	Sam Dugin
Walter O'Donnell	Kay Wyman
Paul Braun	Joan Waller

GATELY DEVELOPMENT LABORATORY 742

Barrington, N. J.
Products: The "Super Horn" corner type folded horn loudspeaker enclosure; and the "Purest," a folded horn not requiring corner location.

IN ATTENDANCE

Edward J. Gately, Jr.	Nancy S. Gately
Thomas A. Benham	Jerry Landis

GATES RADIO COMPANY 618

123 Hampshire St., Quincy, Ill.
Products: Audio equipment, including new model CC-1 ten-position audio control console, especially designed for TV use. Gates remote equipment, including the model CB-60 Dynamote. Plug-in audio amplifiers.

IN ATTENDANCE

John Haerle	E. J. Wilder

GENERAL ELECTRIC COMPANY 531

Electronics Park, Syracuse, N. Y.
Products: Phono accessories and high-fidelity products.

IN ATTENDANCE

T. J. Nicholson	F. Beguin
Mark Woodworth	P. E. Humphreys
Roy Dally	

SAM GOODY 508

235 W. 49 St., New York 19, N. Y.
Products: Speakers, enclosures, turntables, amplifiers, tuners, records.

IN ATTENDANCE

Morris Lichtman	Norman G. Long
Newton A. Chanin	

GRAY RESEARCH & DEVELOPMENT COMPANY 503

658 Hilliard St., Manchester, Conn.
Products: Transcription arms and equalizers; audio systems; Audograph dictating machines.

IN ATTENDANCE

C. B. Hayes	N. F. Smith
C. Snow	

THE HALLICRAFTERS COMPANY 504

4401 W. Fifth Ave., Chicago 24, Ill.
Products: Hi-fidelity tuners and amplifiers; AM-FM radios.

IN ATTENDANCE

Wm. J. Halligan, Jr.	Fritz A. Franke
John R. Halligan	Wm. Brown

H. A. HARTLEY CO., INC. 533

521 E. 162nd St., New York 51, N. Y.
Products: Amplifiers, speakers, phono equipment, tuners, cabinets.

IN ATTENDANCE

H. A. Hartley	Robert Schmetterer

HARVEY RADIO COMPANY, INC. 631

103 W. 43rd St., New York 36, N. Y.
Products: Distributors for complete high-fidelity home music systems and components; tape recorders; radio parts and broadcast supplies.

IN ATTENDANCE

Harvey E. Sampson	Abe Kobrin
Roy Neusch	James Carroll

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

HIGH FIDELITY MAGAZINE 552-553

The Publishing House, Great Barrington, Mass.
Products: High Fidelity magazine; Hi-Fi Sales and Service; Communication Engineering; TV & Radio Engineering.

IN ATTENDANCE

Milton B. Sleeper, Charles Fowler, Roy Allison, John Conly, Warren Syer

HUDSON RADIO & TELEVISION CORP. 736

48 W. 48th St., New York 36, N. Y.
Products: Standard high-fidelity equipment.

IN ATTENDANCE

Roy Bellinson, Harold Weinberg, Herman Holstein, Norman Berke, Lester Klein, Jack Lee, Sidney Krinitz, Irving Berger, Arnold Schwager, Mike Berman

JENSEN MANUFACTURING COMPANY 518-519

6601 S. Laramie Ave., Chicago 38, Ill.
Products: Single-unit, coaxial, and triaxial loudspeakers; complete reproducers; three-way system components; low- and high-frequency units ("woofers" and "tweeters"); crossover and filter networks; level controls; transformers; back-loading folded-horn and bass-reflex cabinets; commercial sound equipment.

IN ATTENDANCE

Chas. A. Hansen, Karl Kramer, Horace L. White, Louis W. Selsor

THE KELTON COMPANY, INC. 534-535

958 Massachusetts Ave., Cambridge 39, Mass.
Products: Complete hi-fidelity home music systems; loudspeaker enclosures; phonographs; amplifiers; record changers and cartridges—FM Component.

IN ATTENDANCE

Albert E. Bachmann, Henry C. Lang, Thomas F. Murphy, John R. Thornton, Bernard Edelman, George Hartstone, James Lynch

KINGDOM PRODUCTS, LTD. 737

45 W. 45th St., New York 36, N. Y.
Products: KT66 tubes; Lorenz speakers; Portable Gramophone; hi-fi equipment and components.

IN ATTENDANCE

Adolph L. Gross

KLIPSCH EASTERN, INC. 734

420 Madison Ave., New York 17, N. Y.
Products: The Klipschorn and the Rebel, loudspeaker systems, cabinets, and auxiliary equipment.

IN ATTENDANCE

Paul W. Klipsch, L. McCandless, C. A. Paquin, E. P. McQueen, Eugene Altman, N. Norman, C. Farbach

KLOSS INDUSTRIES 714

10 Arrow St., Cambridge 38, Mass.
Products: Baruch-Lang corner loudspeaker systems.

IN ATTENDANCE

Henry E. Kloss, J. A. Hofmann

LANGEVIN MANUFACTURING CORPORATION 502

37 W. 65th St., New York 23, N. Y.
Products: Langevin audio amplifiers; Langevin broadcast audio equipment; Langevin transformers.

IN ATTENDANCE

Leo. G. Sands, F. K. Hankinson, F. J. Neidig, Leroy Bremmer, W. W. Dean, Paul C. Marrone, Donald S. Morgan, George H. Grenier, Nathan Paulson

JAMES B. LANSING SOUND, INC. 731

2439 Fletcher Dr., Los Angeles 39, Calif.
Products: Loudspeakers.

IN ATTENDANCE

William H. Thomas, George F. Halkides

LEONARD RADIO, INC. 536-537

69 Cortlandt St., New York 7, N. Y.
Products: Radio Craftsmen, Bell, Brook, Jensen, Electro-Voice, H. H. Scott, Weathers, Bogen, Browning, Garrard, V-M, Pentron, Concertone, Presto, Duotone, Stephens, Altec, Newcomb, Wharfedale, Audak, Pickering, Fairchild, G. E., Clarkstan, Brook, Pilot, Hallicrafters, Tannoy, Pedersen, Bozak, and all related high-fidelity audio equipment.

IN ATTENDANCE

Leonard Levy, Bernard Bernstein, Lawrence J. Silverman, Bill Barman, Sidney Schugar, Leonard Weiner, Ellis Rosen, Sam Lewis, Norman Sanders

LIVINGSTON ELECTRONIC CORPORATION 647

Livingston, N. J.
Products: Monaural and binaural reproducer arms; recordings and associated equipment.

IN ATTENDANCE

C. E. Smiley, John Hall, R. W. Smiley

MADISON RADIO SOUND 646

Main St., Madison, N. J.
Products: Amplifiers.

IN ATTENDANCE

John Nigro, Burton Smith

MAGNECORD, INC. 604-605

225 W. Ohio St., Chicago 10, Ill.
Products: Professional magnetic tape recording equipment for home, broadcast, industrial research and educational markets. Pre-recorded tape library of classical music, etc.
Trade Names: MAGNECORDER; MAGNECORDETTE; VOYAGER.

IN ATTENDANCE

R. S. McQueen, Harry Miller, Wm. Blocki, J. S. Boyers

JEFF MARKELL ASSOCIATES 608

108 W. 14th St., New York 11, N. Y.
Products: Cabinets for residential audio systems.

IN ATTENDANCE

Jeff Markell, Mary Hooker

H. S. MARTIN & COMPANY 505

1916 Greenleaf St., Evanston, Ill.
Products: High-fidelity amplifier; preamplifier; FM-AM tuners.

IN ATTENDANCE

C. J. Saberson, Harry Olson, John Clark

McINTOSH LABORATORY, INC. 516

320 Water St., Binghamton, N. Y.
Products: High-fidelity audio amplifiers.

IN ATTENDANCE

Frank McIntosh, Gordon Gow, Harry Miller

MEASUREMENTS CORPORATION 527

Boonton, New Jersey
Products: Electronic test equipment including intermodulation meters, pulse generators, square wave generators, standard signal generators, television signal generators, UHF radio noise and field strength meter, peak voltmeters, R.F. attenuators, megacycle meters, vacuum-tube voltmeters, special test instruments.

IN ATTENDANCE

Harry W. Houck, Nelson C. Doland, Jr., Jerry B. Minter, Ronald C. Pittenger, John M. van Beuren

MINNESOTA MINING & MFG. CO. 550

900 Fauquier Ave., St. Paul 6, Minn.
Products: "Scotch" brand magnetic tape and accesories.

IN ATTENDANCE

Paul W. Jansen, W. F. Enright, J. J. McDonald, P. B. Van Deventer, Dan Denham

NEWCOMB AUDIO PRODUCTS CO. 623

6824 Lexington Ave., Hollywood 38, Calif.
Products: Home music amplifiers; phonographs; transcription players, public-address equipment.

IN ATTENDANCE

Robert Newcomb, Donald Warner

PEERLESS RADIO DISTRIBUTORS, INC. 547

92-32 Merrick Road, Jamaica 33, L. I., N. Y.
Products: David Bogen, Newcomb Audio, Rauland, GE, Electro-Voice, Concertone, Altec Lansing, Brook Electronics, VM, Browning Labs, Radio Craftsmen, Stephens, Pederson.

IN ATTENDANCE

Charles Shankman, David Bernstein, Irving Glickman, Leo Gross, Walter Richman, Gus Klavas, Frank deCarlo, H. Rousseau, L. Risman, J. Thomsen, Eliot Finkels

PENTRON CORPORATION 711

664 N. Michigan Ave., Chicago 11, Ill.
Products: Tape recorders, tape playback unit, electronic mike mixer, basic tape mechanism, preamplifiers, AM tuner, foot pedal, speaker and baffle, large-reel adaptor, telephone pickup, and other accessories.

IN ATTENDANCE

Irving Rossman, M. M. Bermann, Robert Stang, Walter Fleischer

PERMOFLUX CORPORATION 640

4900 W. Grand Ave., Chicago 39, Ill.
Products: High-fidelity loudspeakers; speaker enclosures; high-fidelity headphones.

IN ATTENDANCE

L. M. Heineman, R. S. Fenton, F. J. Van Alstyne, A. H. Binash, S. J. Hyman, Rudy Napolitan

PICKERING AND COMPANY, INC. 624-625

309 Woods Ave., Oceanside, N. Y.
Products: Magnetic pickups; transcription arms; equalizers; preamplifiers; equalizer-preamplifiers.

IN ATTENDANCE

Walter O. Stanton, George P. Petetin

PILOT RADIO CORPORATION 729-730

37–06 Thirty-Sixth St., Long Island City 1, N. Y.
Products: Tuners, amplifiers, converters, and TV chassis.

IN ATTENDANCE

Adolph L. Gross, Louis Abels, S. Sass, Richard Shottenfield, Joseph M. Benjamin, James I. Benjamin, Frank Hajek, Sol Abilook, I. W. Wyckoff

PORTABLE GRAMOPHONE CO., INC. 737

45 W. 45th St., New York 36, N. Y.
Products: KT66 tubes; Lorenz speakers; Portable Gramophone; hi-fi equipment and components.

IN ATTENDANCE

Adolph L. Gross

PRECISION ELECTRONICS, INC. 549

9101 King St., Franklin Park, Ill.
Products: 210PA, 206PA, 215BA, 50PG2, LJ2, and RC-1 amplifiers, and other new products.

IN ATTENDANCE

Wm. S. Grommes, A. A. Hart, L. B. Green

PRESTO RECORDING CORPORATION 621

Box 500, Paramus, N. J.
Products: Disc and tape recording and reproducing equipment, lacquer coated aluminum blank recording discs.

IN ATTENDANCE

Thomas B. Aldrich, Austin B. Sholes, George J. Saliba, M. M. Gruber, Alfred Jorysz, Thomas Aye, Henry Geist, Michel J. Cudahy

RADIO CORP. OF AMERICA, RCA VICTOR DIV. 727-728 732-733 829-830

Front & Cooper Sts., Camden 2, N. J.
Products: Hi-fidelity sound equipment; magnetic recorder-projector.

IN ATTENDANCE

John Hemberger, S. A. Caldwell, Daniel Berne, Harry Taylor

THE RADIO CRAFTSMEN, INC. 726

4401 N. Ravenswood Ave., Chicago 40, Ill.
Products: FM-AM tuners; hi-fi amplifiers; record changer; speaker systems; TV receivers.

IN ATTENDANCE

John H. Cashman, Mitchell Cotter, Lee Hicks, Jules Bressler

RADIO ENGINEERING LABORATORIES, INC. 720

38–01 Queens Blvd., Long Island City 1,
Products: REL model 646-C FM tuner.

IN ATTENDANCE

C. R. Runyon, Jr., Ben Tullius, Frank A. Gunther, V. E. Brennan, James R. Day, George Papamarcos, Joseph Behr, Shepard Parker, C. R. Runyon III, Paul Gruber, Joseph Tennis, Benji Hara

RADIO MAGAZINES, INC. 616

204 Front St., Mineola, N. Y.
Products: AUDIO ENGINEERING; Audio Anthology; the 2nd Audio Anthology.

IN ATTENDANCE

Henry A. Schober, Sanford L. Cahn, C. G. McProud, Sanford R. Cowan, Harrie K. Richardson, Harry N. Reizes, Edgar E. Newman

RADIO STATION WQXR 539

229 W. 43rd St., New York 36, N. Y.
Products: WQXR programs and promotional material.

IN ATTENDANCE

Mary Rice Anderson, Javen Masoomian, Robert Kneiger, Robt. Cobaugh, Louis Kleinklaus

RADIO-WIRE-TELEVISION, INC. 543
Lafayette Radio

100 Sixth Ave., New York 13, N. Y.
Products: High-fidelity and recording equipment.

IN ATTENDANCE

Arthur Wohl, M. H. Kranzberg, Murray Pfeffer, A. Pletman, Seymour Moed, Gerald Russell, Lionel Zimmerman, Paul Savell, Robert Murray, William Nagata, Joseph Schocken, Betty Blank, Harold M. Sperber

REEVES SOUNDCRAFT CORP. 603

10 E. 52nd St., New York 22, N. Y.
Products: Magnetic recording tape; recording blank discs; Magna-Stripe; styli; magnetic film.

IN ATTENDANCE

Frank B. Rogers, Jr., Thomas J. Dempsey, William H. Deacy, William A. Morrison, Donald E. Ward, George Bassett

REGENCY DIVISION, 724
Industrial Development Engineering Associates, Inc.

7900 Pendleton Pike, Indianapolis 26, Ind.
Products: Regency high-fidelity audio amplifier.

IN ATTENDANCE

Edward C. Tudor, Ray A. Morris, Richard W. Mitchell, R. Gordon Dougherty

REVERE CAMERA CO. 722-723

320 E. 21st St., Chicago 16, Ill.
Products: Complete line magnetic tape recorders and sound equipment.

IN ATTENDANCE

Les Berger, L. Wald

REK-O-KUT COMPANY 636

38–01 Queens Bldv., Long Island City 1, N. Y.
Products: 12" and 16" precision transcription and playback turntables; disc recorder overhead-type mechanisms (12" & 16"); portable high-fidelity P.A. systems incorporating either 3-speed or continuously-variable-speed turntables; portable phono players; portable disc recorder.
Brand Names: RHYTHMASTER, RECITALIST, CHALLENGER DELUXE.

IN ATTENDANCE

George Silber, Avery Yudin, Sydney Simonson, Fred Moulin, Philip Dubson

RIVER EDGE INDUSTRIES 707

5 River Edge Road, River Edge, N. J.
Products: Hi-fidelity radio-TV cabinets and speaker enclosures, hi-fidelity radio-phono-TV cabinets and speaker combinations.

IN ATTENDANCE

Walter Godfrey, Henry R. Sherwin, Leon Adelman, Martin Berlin, Sylvia Mack, Virginia Rogers, George Petitt, G. J. Rodgers, Chas. Lienau, E. Wilks

ROCKBAR CORPORATION 641

211 E. 37th St., New York 16, N. Y.
Products: Record changers; record players; transcription turntables; cartridges; mounting bases.

IN ATTENDANCE

Syd Wimpie, Jack Willson, Ed Straw, Wm. MacAteer, C. Collaro

HERMON HOSMER SCOTT, INC. 628

385 Putnam Ave., Cambridge 39, Mass.
Products: High-fidelity amplifiers; Dynaural noise suppressors and amplifiers; sound measuring and laboratory apparatus; electronic laboratory equipment.

IN ATTENDANCE

Hermon H. Scott, Victor H. Pomper, Dan R. von Recklinghausen, Edmond G. Dyett, Jr.

SHIELDS LABORATORIES, INC. 712

810 N. Lincoln Ave., Pittsburgh 12, Pa.
Products: Audio amplifiers, loudspeaker enclosures, preamplifiers, various types of measuring instruments.

IN ATTENDANCE

John P. Shields, Reese R. Neal, Lloyd G. Orazi, Peggie A. Kroen

MARK SIMPSON MFG. CO., INC. 715

32–28 49th St., Long Island City 3, N. Y.
Products: 10- and 20-watt high-fidelity amplifiers; tape recorders; electronic microphone mixer; public-address systems; intercommunication systems; disc recorders.

IN ATTENDANCE

Miryam Simpson, G. Leonard Werner, Ralph Hasen, George Watson, Henry Berlin

SONOCRAFT CORPORATION 642

115 W. 45th St., New York 36, N. Y.
Products: Recording equipment for broadcast and recording studios; audio-visual equipment for institutions, schools, industrial concerns and advertising agencies; distributors of leading brands of recording equipment, playback equipment, accessories, tape and disc.

IN ATTENDANCE

Herbert H. Borchardt, Harold H. Oppenheimer, Gary M. Behrendt, Fred M. Lissa, George Bilick, Howard Silver, G. F. Miller, Joseph Gschaar, Leslie Lee

SONOTONE CORPORATION 741

Elmsford, New York
Products: Phonograph pickups; phonograph needles.

IN ATTENDANCE

R. L. Lewis, R. M. Mitchell, N. H. Dieter

STEPHENS MANUFACTURING CORP. 701-702

8538 Warner Drive, Culver City, Calif.
Products: High-fidelity loudspeakers; loudspeaker enclosures; amplifiers; condenser microphones; wireless microphones; multicellular horns; high-frequency drivers; theatre loudspeakers.

IN ATTENDANCE

Robert L. Stephens
Steve Van Roekel
Jesse Adams
Neal Pierce
Robert C. Tetherow

STROMBERG-CARLSON COMPANY 540

1225 Clifford Ave., Rochester 21, N. Y.
Products: Stromberg-Carlson Custom Four Hundred high-fidelity components and completed units in cabinets.

IN ATTENDANCE

A. G. Schifino
J. W. Farrow
M. W. Zegee
F. A. Spinelli
F. W. Haupt
R. P. Weis
F. H. Slaymaker

SUN RADIO & ELECTRONICS CO., INC. 601

650 Sixth Ave., New York 11, N. Y.
Products: Altec Lansing, Astatic, Audak, Audio Devices, Bell Sound, Bogen, Browning, Clarkstan, Concertone, Cook Labs, Electro-Voice Fairchild, G.E., Fisher Radio, Gray, Jensen Mfg., James B. Lansing, Newcomb, Pentron, Pickering, Grommes, RCA, Craftsmen, Rek-O-Kut. H. H. Scott, Stephens, Stromberg-Carlson, Tech-Master, Meissner, University, Waveforms, Webcor, Garrard, Livingston, Pilot, Cabinart, River-Edge, Herman Miller, Jeff Markell, Middlesex, Lumite, Scotch tape.

IN ATTENDANCE

Samuel Schwartz
Samuel Gerard
Irving Hodas
Joseph Greenfield
Bernard Cohen
Irving Bien
Arthur Waxman
Morris Brown
George Panayotte
Elton Nachman
Latney Hooker

TANNOY CANADA LIMITED 607

In association with **Tannoy Ltd.,**
West Norwood, London S.E. 27, England
Products: Tannoy 12" Dual Concentric loudspeaker; Tannoy 15" Dual Concentric loudspeaker; Tannoy 12" direct radiator; Tannoy 100-watt high-efficiency loudspeaker. Wide range dynamic microphone. High-fidelity velocity microphone. Dynamic cardioid microphone. Dynamic tube microphone.

IN ATTENDANCE

Michael H. Fountain
Frederick A. Towler
Mrs. M. Towler
Terence B. Livingstone

TAPEMASTER INC. 551

13 W. Hubbard St., Chicago 10, Ill.
Products: Tape recorders; tape transport mechanisms; preamplifiers.

IN ATTENDANCE

John S. Margolin
R. M. Karet
W. L. Brooks
Ralph Epstein

TELECTRO INDUSTRIES CORP. 530

35–16 37th St., Long Island City 1, N. Y.
Products: Telectrotape recorder.

IN ATTENDANCE

Harry Sussman
Stanley Rosenberg
Fred Kantor

THE TETRAD COMPANY 719

62 St. Mary St., Yonkers 2, N. Y.
Products: Diamond phonograph styli; microscope and shadowgraph exhibits of test styli; color slide projection of methods of manufacture of phonograph styli; diamond exhibit; charts and graphs; test and demonstration of effect of worn styli on records.

IN ATTENDANCE

Morton V. Marcus
Howard M. Weinberger
Emmanuel J. Marcus
Edward P. Delaney
Irmina M. Lota
Jeanne A. Axelrod
Leonard Miller

THORENS COMPANY 602

2020 Jericho Turnpike, New Hyde Park, N. Y.
Products: Swiss-made record changers, record players, electric mounting units, electric motors, spring motors, phonograps, radio tuners.

IN ATTENDANCE

R. K. Kind — E. L. Childs
P. W. Kind — J. P. Donohue

TUNG-SOL ELECTRIC, INC. 512

95 Eighth Ave., Newark 4, N. J.
Products: Receiving tubes; semi-conductor products.

IN ATTENDANCE

John D. Van der Veer — Roger S. Whitlock
John J. Corcoran — Richard Jandl
Fred A. Warren — Alex V. Mitchell
C. Everett Coon — LeRoy Emmel

ULTRASONIC CORPORATION 704

61 Rogers St., Cambridge 42, Mass.
Products: Demonstration of the Ultrasonic Model U-25 loudspeaker and new package unit incorporating record player, amplifier, and speaker.

IN ATTENDANCE

Dale L. Button — Edwin C. Reynolds
William J. Gagnon — John J. Welch

UNITED TRANSFORMER CORP. 522

150 Varick St., New York 13, N. Y.
Products: Transformers, amplifiers, kits, and filters.

IN ATTENDANCE

S. L. Baraf — S. Mannville
Joe Barecca — Ted Craig
Hank Russell

UNIVERSITY LOUDSPEAKERS, INC. 501

80 S. Kensico Ave., White Plains, N. Y.
Products: Woofers, tweeters, mid-range speakers; crossover networks; cabinets.

IN ATTENDANCE

Irving Golin — Saul White
Sidney Levy — Abe Cohen
Arthur Blumenfeld — Edward Reiss
Lawrence J. Epstein — Symour Blumenfeld
Robert S. Reiss

UTAH RADIO PRODUCTS CO., INC. 606

1123 E. Franklin St., Huntington, Ind.
Products: Wall baffles; commercial speakers; high-fidelity speakers; high-fidelity enclosures; high-fidelity ensembles.

IN ATTENDANCE

A. H. Schenkel — L. A. Wells
F. L. Pyle — Jean Musselman
W. A. Dill, Jr. — P. E. Monsey

VIDEO CORPORATION OF AMERICA 708

229 W. 28th St., New York 1, N. Y.
Products: High-fidelity radio-phonographs and phonograph combinations.

IN ATTENDANCE

Morton Kronengold — A. Ellis
Michael Platzman — F. Ischia
Wm. Londin

V-M CORPORATION 740

4th & Park Sts., Benton Harbor, Mich.
Products: V-M hi-fidelity record changers and phonographs.

IN ATTENDANCE

Roy Parr — Alan Woolf
Irving Woolf

WEATHERS INDUSTRIES 743

66 E. Gloucester Pike, Barrington, N. J.
Products: Complete line of high-fidelity capacitance-type phonograph pickups and a new pressure gauge for measuring tone arm pressure.

IN ATTENDANCE

Paul W. Weathers — David W. Coffin
Edward J. Gately, Jr. — Harry Leuthold

WEBSTER-CHICAGO CORPORATION 633

5610 W. Bloomingdale Ave., Chicago, 39, Ill.
Products: Magnetic recorders, Fonografs, and Diskchangers.

IN ATTENDANCE

N. C. Owen — N. Mackay
H. R. Letzter — J. Austin
E. W. Olson — C. Ollstein
G. F. Harder — C. L. Dwyer
S. T. Seaman — H. L. Ballard
C. S. Castle

WESTMINSTER RECORDING CO., INC. 620

275 7th Ave., New York 1, N. Y.
Products: Phonograph Records

IN ATTENDANCE

Michael Naida — William Lerner
Henry L. Gage — Martin Shapiro
Harry Rubin — Edward Talmus
Kurt List

ZENITH RADIO CORPORATION 548, 832-833

6001 Dickens Ave., Chicago 39, Ill.
Products: Phonevision, high-fidelity sets, radio and television sets, hearing aids.

IN ATTENDANCE

Farrell Davisson — G. J. Roach
Erik Isgrig — R. C. Wallace
Jane Temple

ZIFF-DAVIS PUBLISHING COMPANY 514
(Radio & Television News)

366 Madison Ave., New York 17, N. Y.
Products: Radio & Television News, and other magazines.

IN ATTENDANCE

Oliver Read — Leonard L. Osten
William Stocklin — Murray Goldman
Harold Renne — Jerome Jacobs
Charles Tepfer — John McArdie
N. Rosa

BASS CONTROL

(*from page 25*)

is used to set the level of the high-frequency response in comparison to the bass. In some respects, this part of the circuit is worthy of special attention in itself, inasmuch as the slope of the high-frequency response curve is not changed, but merely the relative amplitude of all of the highs. This means that it is possible to achieve emphasis of clarity giving middle highs without adding excessive high-frequency noise to the reproduction.

While the unit shown in *Fig.* 5 obtains power from the main amplifier, the system shown in *Fig.* 4 is completely self contained, and is designed for easy insertion between a crystal pickup or a preamplifier and the main power amplifier. The self-contained power supply, shown in *Fig.* 6, furnishes a B+ voltage of about 150, which is adequate for most purposes. This supply can be incorporated into a single chassis, as in *Fig.* 4, and will mount readily in a 3½ × 6 × 2 in. chassis. In a

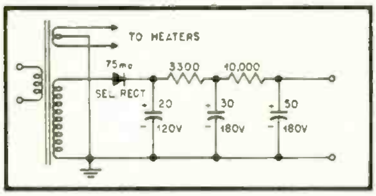


Fig. 6. Power supply incorporated in unit shown

compact, self contained, unit, care should be taken that the two dual triodes are located in the minimum field from the power transformer. This position can usually be located by means of a small pickup coil—such as a magnetic phono cartridge—and a high-gain amplifier, the best procedure being to determine the point of minimum field intensity from the power transformer before any of the components are mounted. This may be done by connecting the primary leads of the transformer and moving the exploring coil about it until the region of minimum field is established.

Performance

The frequency of each resonant circuitis determined by the values of the three resistors and capacitors in the feedback loop. Increasing the value of any of these components will lower the resonant frequency, while decreasing the values will raise the point of resonance. Suggested values for specific frequencies are shown on the diagram, but superior performance with a given audio installation may likely be obtained with a different group of frequencies selected to match the resonances of the system.

Bass tone is likewise strongly influenced by the amount of low-frequency distortion present in the signal source or reproducing equipment. In the construction of the three-way bass circuit, the use of different components tend to alter the character of the resonant decay curve due to changed linearity characteristics. For example, the substitution of pentodes for the triodes shown in the schematic may produce significant, though not necessarily undesirable, changes in tone color. Likewise, when using larger values of capacitance in the feedback loops, such as .01 μf or greater, the effect of dielectric hysteresis may alter the resultant sound, but in some cases this may be beneficial.

Aside from the benefits of deeper and more musical bass, the use of the three-element bass control seems almost to add a new dimension to radio broadcasts and the various elements of a station's technical personality seem to stand out more clearly due to the superior reproduction of low-frequency transients. For example a control room microphone that is poorly shock mounted may exhibit an interesting serious of thumps and bumps while the operator is reading news or changing records in the middle of an announcement. Similarly, matters like hum in different audio channels, microphonics, turntable or record rumble, air conditioner noises, and so on, tend to show up more clearly. Of course, if these sounds become too distracting they can easily be eliminated by proper setting of the bass controls, a procedure somewhat easier than getting out the hammer and saw to modify the acoustic resonances of the room or cabinet.

In conclusion, the use of multiple resonance bass circuits should appeal to many listeners who desire fullness in the lower registers. To date, the only detrimental effects that have been noted when using circuits of this nature are found when the electronic resonance is set too closely to one of the mechanical resonances of the system, or when excessive distortion elsewhere has tended to counteract the benefits derived. Particular attention might be paid to the elimination of cabinet or room rattles which may be generated by the fundamental bass tones. Similarly, amplifiers such as the "Ultra-Linear" are recommended.

EVERYMAN'S AMPLIFIER

(*from page 40*)

Control. We realize, of course, that the loudness control is a much disputed subject at the present time and that there are those who prefer such a control and those who prefer the standard bass and treble controls. Consequently, we provided what we felt was the best compromise—a bass and treble compensated volume control whose compensation is effective mainly at low volume, plus separate bass and treble controls capable of either completely nullifying the effect of the volume control compensation or adding to it for a higher degree of bass and treble boost or cut.

By actual measurement, the volume control adds 2.4 db bass boost at 50 cps, 0.3

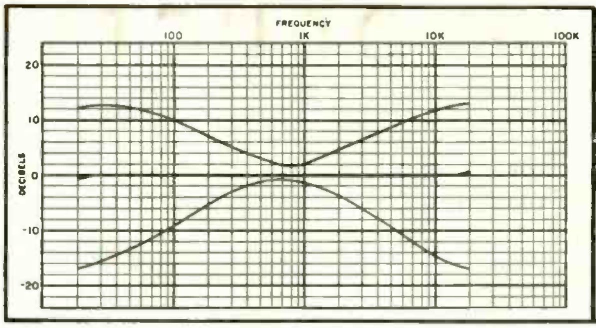
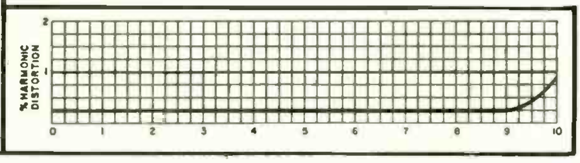


Fig. 2 (left). Limits of tone-control range, providing maximum boosts of around 12 db for both bass and treble, and maximum cut of 17 db at both ends. Fig. 4 (above). Harmonic distortion in per cent plotted against output level in watts.



db treble boost at 10,000 cps, and 0.4 db treble boost at 20,000 cps, when set for 4 watts output at the 800 cps tone control crossover frequency; at 1 watt output the volume control adds 3.1 db bass boost at 50 cps, 1.6 db treble boost at 10,000 cps, and 3.7 db treble boost at 20,000 cps.

As can be seen from *Fig.* 2, the tone controls provide 12 db of bass boost and 14 db of bass cut at 50 cps, and 13 db of treble boost and 17 db of treble cut at 20,000 cps. These operating data thus indicate that it would be possible to equalize almost any type of recording characteristics by the combined action of the compensated volume control and the bass and treble controls alone.

However, the provision of fixed equalization networks makes the use of tone-control equalization unnecessary, allowing these controls to provide for varying the tonal response of the amplifier to make up for taste differences and to provide a closer approach to the Fletcher-Munson hearing characteristic than is possible by loudness controls alone.

Circuit configurations of the volume control and bass and treble controls can be seen in the schematic, *Fig.* 3.

5. *Beauty of Appearance* was considered to be a necessary adjunct to, and suggestive of, beauty of function. The "Custom Ten" chassis is finished in black and tube shields and hardware are finished in gold to provide an attractive appearance. Screening of the front panel is in gold set against the black background, and the panel is removable for console cabinet mounting.

6. *Additional Features* which will prove popular are the provision of a set of extension shafts for the controls to make up for varying panel thicknesses in custom cabinets, and a pilot light socket and plug for remote pilot light installation.

Functional Characteristics

As to performance, the "Custom Ten" is designed to be an excellent work-a-day amplifier with response characteristics and hum and distortion figures commensurate with its use with the best modern hi-fi accessories.

Power output of the "Custom Ten" is ten watts at less than 1 per cent distortion (see *Fig.* 4.) Response is 20 to 20,000 cps ± 0.5 db. Hum and noise are 80 db below full output. A hum-balancing control provides positive d.c. bias for the heaters to effect considerable hum reduction.

Amplifier stability is evidenced by the use of more than 15 db of feedback around the output transformer and three amplifier stages to minimizing distortion and to provide the high damping factor needed to reduce speaker distortion.

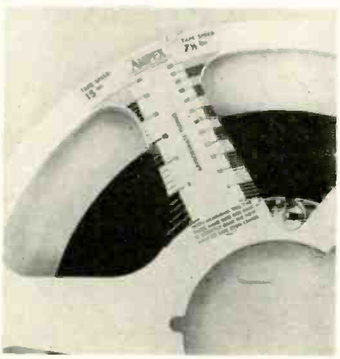
Summing up, the "Custom Ten" has been described as a ten watt hi-fi amplifier of good frequency response and low distortion having such desirable features as: complete provision for recording equalization, all the needed flexibility of tonal variation, three inputs for high-level program sources, one input for either of the two basic types of magnetic pickup, separate output for tape recorder, and beauty of appearance. Provision of these features at low cost should make the "Custom Ten" the "Ford" of hi-fi amplifiers.

NEW PRODUCTS

• **Garrard Model RC90 Record Changer.** Introduced as the finest changer in the company's history, the new Garrard Model RC90 features a new type of silent 4-pole motor with adjustability of all three playing speeds, as well as a number of other improvements over earlier models. Manual playing position cuts out changing mechanism and automatic trip for playing single records. An improved new stepped-pulley drive, with flywheel-type idler wheel assures flutter-free op-

eration. Changing cycle is rapid irrespective of turntable speed. The unit is supplied with two spindles—one for records with standard quarter-inch center hole, and the other for 45's. A muting switch operates during changing cycle, and a suppressor network across the a. c. switch eliminates the conventional "plop" when the machine shuts off. Automatic stop operates at the conclusion of the last record, returning the tone arm to rest, and retracting the idler wheel to avoid "flats". Garrard Sales Corp., 164 Duane St., New York 13, N. Y.

• **Time-Indicating Reel Marker.** Designed for ready application to standard 10½-in. NARTB reels, this new accessory available from Ampex distributors will greatly expedite the editing of magnetic tape, especially when certain portions of a long program must be found quickly. Simply an adhesive sticker with time calibrations for 7½- and 15-in. recording

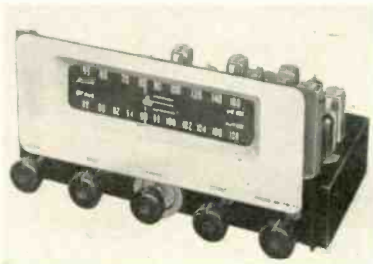


speeds, the device gives an operator a good approximation of the time used and that remaining on recording reels. The manufacturer, Ampex Electric Corporation, Redwood City, Calif., emphasizes that the markers are available only through Ampex distributors; not from the factory.

• **Power Amplifier.** Remarkable performance characteristics are embodied in the new Shields Model SPA-25 amplifier, according to introductory technical information issued by the manufacturer. Frequency response is stated to be 7 to 100,000 cps within ±1 db and rated power output is 25 watts. Intermodulation distortion is virtually non-existent. Internal output impedance of the SPA-25 is less than one ohm, allowing it to act as almost a complete short circuit to any transient distortion produced by the loudspeaker. Adaptable to virtually all types of installations, both domestic and commercial, the amplifier is designed to permit its being switched on or off from a remote point. A socket on the rear of the chassis delivers a.c. and d.c. for the operation of various accessories, including d.c. heater

supply for a preamplifier. The SPA-25 is fully described in a new bulletin which may be obtained from Shields Laboratories, Inc., 303 Shields Building, 810 N. Lincoln Ave., Pittsburgh 12, Pa.

• **High-Fidelity Receiver Chassis.** Newest addition to the extensive line of high-fidelity equipment manufactured by the David Bogen Company, 29 Ninth Ave., New York 14, N. Y., is the Model RR500 10-tube AM-FM receiver chassis which has 10-watt audio output at 3 per cent distortion. The FM circuit features a triode r-f amplifier and a triode mixer,



with a balanced ratio detector. Sensitivity is 7 microvolts input for 30 db quieting and frequency response is 30 to 18,000 cps within ±2 db. AM frequency response is 40 to 4000 within ±3 db. For AM operation, the RR500 is equipped with a low-impedance loop antenna. Design of the push-pull audio amplifier is based on the popular Bogen Model DB10. Included on the rear of the chassis are inputs for phonograph and television. Separate controls are provided for bass and treble. Complete technical details are available from the manufacturer.

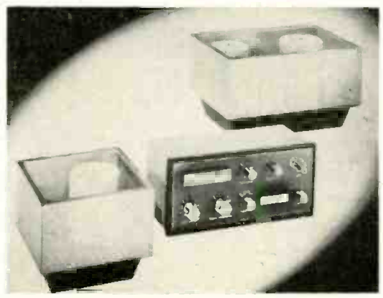
• **Weather-Proof Paging Speakers.** Introduced as the sound industry's first weather-proof speakers with built-in transformers, the new Racon Models RE-20 and RE-11 are rated at 25 and 12 watts, respectively. The former incorpo-

rates a vacuum-impregnated transformer whose taps permit levels of 16, 8, 4, 2, 1.3, 1.0, 0.5, 0.34, and 0.17 when fed from a 70-volt line. Frequency response is 350 to 8500 cps. The lower-powered speaker is equipped with a transformer with a primary tapped at 500, 1000, 1500, and 2000 ohms, and a secondary tapped at 8 and 15 ohms. Frequency response is 450 to 10,000 cps. Racon Electric Co., Inc., 52 E. 19th St., New York 3, N. Y.

• **Precision Decade Inductors.** These units offer a simple method of component substitution in the design of wave filters, tuned circuits, oscillators, and similar devices where precision high "Q" inductors are required. Four basic decade steps—

1–10 mh, 10–100 mh, 100–1000 mh, and 1–10 hy—are available as single units. Powdered molybdenum Permalloy cores are used throughout. Step switching is accomplished by the use of instrument-type rotary switches with low-resistance contacts and laminated self-wiping blade. Manufactured by Torocoil Company, 1374 Mobile Court, St. Louis 10, Mo.

• **High-Fidelity Amplifier Ensemble.** Unique in physical and electronic design, the new Regency amplifier ensemble has been developed and built for the ultimate in audio performance without regard to cost. Consisting of three separate units—a preamp-equalizer, a power amplifier, and a power supply—the equipment is guaranteed forever against defects in materials and workmanship, excepting tubes which carry the standard RETMA 90-day guarantee. All trans-



formers and chokes are hermetically sealed. Non-deteriorating oil-filled capacitors are used in all high-voltage circuits. All units are non-hygroscopic, providing complete protection against the effects of high humidity. Each unit is individually calibrated and is supplied to the user with a response curve. One low- and two high-impedance inputs are provided, each with a level control. In addition to flat frequency response extending beyond the limits of audibility, the Regency equipment allows precise adjustment for room acoustics and individual psycho-acoustics. Manufactured by Regency Division of Industrial Development Engineers Associates, Indianapolis, Ind.

• **Solenoid-Operated Tape Recorders.** Elimination of mechanical linkage in operating controls is featured in the new Ampro tape recorders. Identical except for tape speed and frequency response, the "Celebrity", a 3¾-ips model, and the "Hi-Fi", a 7½-ips recorder, make use of push-button-operated solenoids to control all operating functions. Separate controls are provided for RECORD, FAST FORWARD, REWIND, PLAY, and STOP. Circuitry is so arranged that the STOP key must be depressed between operations. Wow and flutter are stated to be less than one-half of one per cent. Frequency range of the "Celebrity" is 30 to 8500 cps; for the "Hi-Fi" it is 30 to

HARVEY The House of Audio NOW THE LEADER IN HI-FI BINAURAL SOUND EQUIPMENT

PERMOFLUX

DYNAMIC BINAURAL HEADSET

High fidelity headphones, as used by leading artists for orchestration and choir rehearsals. Moving coil type motor assemblies. Frequency response covers the full orchestral scale within the range of human hearing. With adjustable natural cowhide headband, ear cushions, cord and plug.

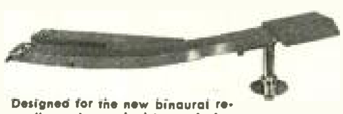
High Fidelity Model B-DHS-28B (12 ohms impedance per phone) **$45.00**

High Fidelity Model B-DHS-17B (300 ohms impedance per phone) **$50.00**

Also in stock for Monaural use.

LIVINGSTON

BINAURAL ARM



Designed for the new binaural recordings. A practical transcription arm which plays either binaural or standard discs, and uses standard cartridges. Beautifully balanced, superbly built, with low-friction horizontal and vertical bearing surfaces, vernier adjustment on stylus pressure, adjustable height for mounting, independent action for each cartridge and other quality characteristics.

Less cartridges **$35.00**

LIVINGSTON

BINAURAL AMPLIFIER

A complete twin-channel amplifier, designed to take fullest advantage of any binaural sound source. Provides two 10-watt Hi-Fi channels, with three twin inputs for disc, tape and binaural broadcasts. Separate tone controls for highs and lows on both channels give utmost binaural control and afford exciting effects with a monaural source. Speaker-reversing switch. Edge-lighted, rear-engraved lucite panel.

With separate power supply in matching cabinets and 3-foot connecting cable **$149.50**

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

COOK BINAURAL PREAMPLIFIER

A complete dual channel control unit for all types of records, as well as tuners and tape units. Selector switch permits playing conventional (monaural) records through two loudspeaker channels if desired. Built to exacting professional standards: full frequency range, low distortion, low noise. Single unit ganged controls for volume, treble, bass (boost and attenuation). Focus control, balances "the orchestra" in two channels to suit listening preference.

Less power supply (usually connected directly to power amplifier) .. **$69.50**

COOK 33⅓ RPM

BINAURAL RECORDS

These magnificent recordings cover the full audible frequency range. There is no equalization; you get the full dynamic range exactly as played by concert artists and symphony orchestras. May be played as monaural long-playing records with ordinary equipment . . . afford marvelous depth and presence when played with binaural arm through a binaural system.

A Partial List of Releases ....each **$5.95**

#2064-BN — BIZET: Introduction to Act I (Carmen); ROSSINI: Overture (La Gazza Ladra); MENDELSSOHN: Scherzo (Midsummer Night's Dream); von WEBER: Overture (Euryanthe)

#2065-BN — MOZART: Symphony #40 in G Minor

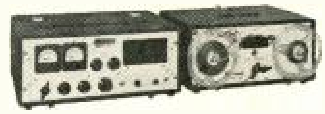
#2066-BN — RIMSKY-KORSAKOV: Dance of the Buffoons; STRAUSS: Emperor Waltz; SAINT-SAENS: Danse Macabre; BRAHMS: Hungarian Dance No. 6

Write for complete list.

Series 30 Binaural Test Record for synchronization and stylus spacing **$2.00**

MAGNECORD

BINAURAL TAPE RECORDER



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13,000 cps. Rewind speed is 120 ips and fast forward is 72 ips for both models. Power output is 3.2 watts. In addition to a self-contained 6 × 9-in. elliptical speaker, outputs are provided for external speaker and for headphone monitoring. Cabinet dimensions are 16½ × 15½ × 10½ ins. Manufactured by the Ampro Corporation, Chicago, Ill.

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● **Thorens Record Changer.** There is hardly any automatic function which might be desired in a record changer which is not present in the new Thorens Model CD-53 "Symphony." Both sides of all standard types of records may be played successively if desired, or the second sides may be played in sequence after playing the first sides of all records loaded on the changer. Ten- and twelve-inch records of the same speed may be intermixed in any order. Records may be repeated or rejected automatically. The pause between records is of adjustable duration. A single knob controls all operating functions. The changer uses two precision motors and is built on a heavy cast-aluminum frame. Normally supplied without cartridges, the CD-53 is designed to accommodate the standard GE variable-reluctance models without alteration. For details write Thorens Company, New Hyde Park, N. Y.

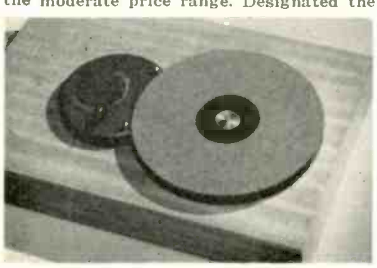
• High-Fidelity Equipment and Speaker Enclosures. Illustrated is Model RC-123, one of the more popular enclosures included in the new line of cabinetry introduced recently by Jeff Markell Associates, 108 W. 14th St., New York 11, N. Y. The unit shown is unique in that it virtually eliminates mechanical vibration transmitted from speaker to amplifier and

phono pickup through use of shock mounting and separating the two enclosures. The speaker cabinet has an internal volume of slightly more than 7 cu. ft. Control panel and changer board are removable for ease of servicing. Over-all dimensions are 43 × 43 × 20 ins. Catalog material will be mailed on request to the manufacturer.

• Fifteen-Inch Speaker. Frequency range of 50 to 10,000 cps and power rating of 25 watts are claimed as basic characteristics of the Model HF15LN hi-fi speaker recently introduced by The Oxford Electric Corporation, 3911 S. Michigan Ave.,

Chicago 15, Ill. Weight of the speaker's Alnico V magnet is 14 oz. and voice coil diameter is 1½ in. Impedance is 8 ohms. The unit is attractively finished in silver hammerloid enamel with a blue pot cover to match other Oxford speakers.

• New Design Turntable. Driven by an "outside" idler, a 3-speed turntable recently introduced also includes a number of other unique features which are said to give greatly improved performance in the moderate price range. Designated the



DR-12, the unit uses a non-metallic table of die stock, and what is called a "floating idler" which decouples motor vibration from chassis. Extreme simplicity of design holds the number of parts to a minimum. Descriptive literature available by writing to D & R, Ltd., 402 E. Gutierrez St., Santa Barbara, Calif.

SOUND HANDBOOK

[*From page 48*]

dition, the line which is a physical extension of the circuit beyond the boundaries of the chassis—is susceptible to hum pick-up. Now suppose that a cathode-follower stage is inserted between the preamplifier and the line, as in *Fig.* 13—9. The capacitance presented to the preamplifier plate is negligible, while the resistance across the line is low enough so that the shunt cable capacitance loses any significance at audio frequencies. The impedance of the parallel combination of cable capacitance and output resistance varies very little over the signal frequency range; even if a higher load value were used the feedback secures low source impedance and near-constant-voltage operation. The danger of hum pickup from the cable is likewise reduced or eliminated.

The ill effects of a long cable connecting high-impedance circuits are thereby overcome, at the price of a virtually distortionless extra stage and a slight loss of voltage. Use of the cathode follower for this application is undoubtedly cheaper and more effective (in low-current circuits) than a pair of step-down and step-up transformers connected at the preamplifier output and amplifier input respectively.

A tube used as a cathode follower requires the normal operating grid bias. If the value of the cathode load resistor is chosen to equal the correct bias resistance the problem is solved automatically. In *Fig.* 13—8, (B) and (C) illustrate methods of providing bias for cathode followers when the load resistance is either lower or higher than the correct bias resistor value.

Phase Splitters

An amplifier stage located between the plate of a single-ended stage and the grids of a push-pull amplifier is the phase splitter. The signal channel up to the phase splitter is "unbalanced," which is to say, the signal potentials are on one line relative to ground. The phase splitter converts the signal channel to a balanced one, and ground becomes the midpoint between two lines whose instantaneous potentials are always opposite in polarity.

Figure 13—10 illustrates various ways of dividing the signal into two components identical in every way except that they are opposite in phase. In (A) advantage is taken of the fact that the two ends of the transformer secondary are 180 deg. out of phase with each other. Transformer coupling has the disadvantage of requiring an input transformer of critical characteristics and relatively high price, but the method is simple, stable, and suited to fixed-bias circuits.

(B) illustrates an often-used design sometimes referred to as the "tapped voltage" circuit. A fraction of the out-

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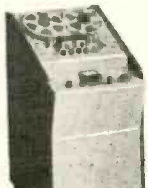

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put of V_1 is tapped off by a voltage divider and applied to the grid of V_2. The output signal of a vacuum-tube is always reversed in phase from the input, so that the output of V_2 is 180 deg. out of phase with the output of V_1. (Since V_2 is in the circuit solely for phase reversal purposes it is properly called a *phase inverter*. This term is often used, although incorrectly, to apply to any complete phase-splitter circuit.) If the fraction of the signal voltage tapped off is equal to the reciprocal of the gain of V_2, the output of V_2 will be equal in amplitude although opposite in phase from the output of V_1, and the two signals may be applied to the inputs of a push-pull stage. R_T may be a fixed resistor of approximately correct value, or it may be a potentiometer that allows a balance adjustment.

The operation of the circuit of (C) is somewhat similar, except that the voltage tapped off by R_1, the lower arm of the voltage divider, is an appreciable part of the total voltage, commonly on the order of 30 per cent. This would create an output from V_2 far in excess of the output of V_1, but the signal from V_2 is applied to a voltage divider with the same resistor R_1 as lower arm. The two signals across R_1 are opposite in phase and tend to cancel until push-pull balance is achieved. The circuit is called a "floating paraphase," because the top of R_1 has a potential which is not anchored, relative to a single signal source, in the conventional manner. The two plate resistors of V_1 and V_2 are often made equal, but correct balance usually requires that the plate resistor of V_2 have a value slightly greater than the resistor of V_1. If a variable resistance is used for the plate resistor of V_2 the circuit may be balanced manually, and the limited self-balancing characteristics relied upon to maintain balance over a period of time. The paraphase circuit has potentially greater stability than the circuit of (B) for the same number and quality of parts. In both circuits the use of a common, unbypassed cathode resistor for V_1 and V_2 (with a value half of that required for the single tube) is advantageous for balance. When the signals are perfectly balanced there is no feedback, but when there is any unbalance negative current feedback is applied to the stage with the larger signal, and effectively positive current feedback to the stage with the smaller one. This is a permissible condition when the inherent distortion is low and when the stage is within a negative feedback loop.

The use of a partial cathode follower for phase splitting is illustrated in (D) of *Fig.* 13—10. All of the voltage across R_2 is fed back to the input, and therefore the output voltage at R_2 is less than the input voltage. If R_1 is equal to R_2 the signal across R_1, which is IR_1, must equal the signal across R_2, which is IR_2; these two signals are balanced relative to ground, and together have an amplitude equal to about 1.8 times the input signal. The circuit is extremely stable, because with the same signal current necessarily flowing through R_1 and R_2

(and their parallel grid resistors), balance is entirely dependent upon the equality of resistor values, and independent of tube characteristics or of operating voltages. Plate resistors and the following grid resistors should be matched by actual measurement rather than by reliance on color codes.

The cathode-loaded phase splitter has very low distortion and the ability to handle large input signals. It will be seen that the output across R_1 is subject to negative current feedback, and that the output across R_2 is subject to negative voltage feedback. The main drawback of the "split-load" or "cathodyne" circuit is a matter of ecenomy, in space and cost; other circuits furnish appreciable gain. The fact that the cathode is well above ground potential also makes the stage susceptible to hum.

The cross-coupled phase splitter,[3] illustrated in (E) of Fig. 13—10, is a self-balancing circuit in which the two voltage amplifiers V_3 and V_4 are driven by cathode followers V_1 and V_2. Note that R_1 and R_2 are connected as cathode resistors for V_3 and V_4 respectively, and as grid resistors for V_4 and V_3 respectively, so that the voltage across either is coupled to both V_3 and V_4, but in opposite phase. (Cathode-to-ground and grid-to-ground signal voltages are always opposite in sense).

A separate circuit for correcting an imperfectly balanced push-pull signal[4] appears in *Fig.* 13—11. Restoration of balance is achieved through the cross-coupling capacitors, C_1 and C_2 connected to the cathode follower outputs.

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CONSTANT-RESISTANCE CROSSOVERS

(*from page 22*)

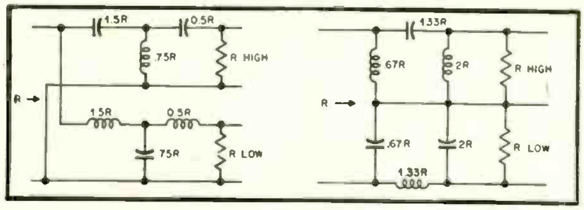

Fig. 6. Complete design data for the two constant-resistance arrangements using three-element sections.

$$P_H = \frac{E^2}{R} \cdot \frac{x^6}{1+x^6} \quad (39)$$

$$db_H = 10 \log_{10}\left[\frac{x^6+1}{x^6}\right] \quad (40)$$

$$\phi_H = \tan^{-1}\frac{2x^2-1}{x^3-2x}$$

$$= \left(\tan^{-1}\frac{2x-x^3}{1-2x^2}\right) - \frac{3\pi}{2} \quad (41)$$

showing a constant phase difference of $3\pi/2$ or 270 deg.

Possible configurations using this relationship are shown at *Fig. 6*.

Practical Aspects

Figure 7 shows the response curves in the vicinity of crossover for each of these arrangements, with the addition of four-element filters, the derivations for which are not given. Stress is often placed on the slope of a crossover filter, the implication being that the steeper it is the better. Presumably this is a result of a desire to ensure that each unit handles only those frequencies for which it is intended, and that frequencies beyond its range are attenuated as much as possible. In the case of high-pass filters this can have good reason, because frequencies below the acoustic cut-off of a loudspeaker suffer distortion if permitted to pass, and can also injure the voice coil assembly.

But there are other aspects that deserve attention. How about the loudspeaker impedance characteristic? The filters are designed on the basis of feeding into a constant-resistance load at each output. The properties of these networks depends upon correct termination. Practical dynamic loudspeakers depart from this ideal in two ways:

(a) the motional impedance, near resonance particularly, contributes a rise in electrical impedance, similar to that of a parallel resonant circuit;

(b) the voice-coil inductance causes an inductive rise in impedance at the higher frequencies in the unit's range.

With some filter configurations, the latter effect can be compensated for, and the former effect probably takes place at frequencies well removed from crossover, and so will not affect the filter characteristic appreciably.

Voice-coil inductance can be compensated for by using a filter that has series inductance at the output end of the low-pass unit. The actual voice-coil inductance is subtracted from the nominal value of this inductance, given by the design data, and the filter inductance adjusted to pad the total inductance out to the design value.

Assuming that such discrepancies are taken care of, what about production deviation from theoretical values? The larger the number of components required, the greater the possible number of combinations of error. Assume for simplicity that the errors on one filter are all the same way. Then *Fig. 8* shows the deviation from level over-all response for each configuration, when the values are 10 per cent off nominal either way. It will be noted that the error not only produces greater deviation from zero level with the more complicated circuits, but also produces a more rapid change in level with frequency, which is known to give more coloration to reproduction than a gradual slope.

Confusion has sometimes arisen in defining the slope of a cut-off. The author prefers to designate a characteristic by its ultimate slope. Others seem to use the slope at the crossover point, which, for constant-resistance types, is just half the ultimate. These slopes are shown by construction lines in *Fig. 7*, and the following table lists the values in db/octave.

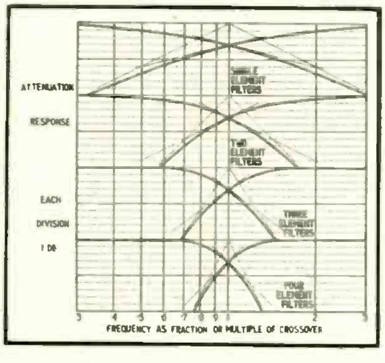

Fig. 7. Attenuation responses of composite filters in the vicinity of crossover. Construction lines show the slope at crossover, and the ultimate slope.

Number of elements per filter	Slope at crossover. (db/octave)	Ultimate slope. (db/octave)
1	3	6
2	6	12
3	9	18
4	12	24

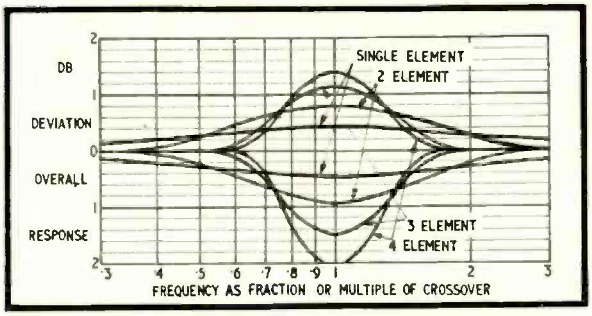

Fig. 8. Showing the deviation in combined response from level, due to an error of 10 per cent, either way, in component values for each filter section.

The reason for greater and more sudden deviation with error in the more complicated filters is evident from the greater slope they possess at crossover. The steepness of the phase characteristics, shown in *Fig.* 9, also means that error can produce greater phase deviation between the two units with the more complicated filters.

Another feature about reproduction is its handling of transients. It is well known that there is an inherent limit to the sharpness of cut-off before transient distortion begins. But doesn't the use of complementary responses, so the overall result is flat, avoid this? Transient response is tied up with how a circuit handles wavefronts, as distinct from continuous waves. Although relative phase, within a cycle or two, does not matter in the reproduction of steady composite tones, it has considerable effect upon wavefronts. For faithful treatment of transients, all component frequencies should be passed on without any delay, or else with uniform delay.

The phase responses of the low-pass filters are shown in *Fig.* 9. The curve for the high-pass filter is exactly similar in each case, but advanced by the total ultimate phase change, which is the same as the constant phase difference noted in the foregoing analysis, in each case. Use of constant-resistance types ensures that there is no change in relative phase between the two outputs, because the difference is constant, but the *absolute* change of phase for both outputs together becomes more rapid at crossover as the number of elements is increased.

In the single-element filters the phase change is so gradual that decade of frequency is required to accommodate a change of 80 deg. The ultimate change is only 90 deg.

In two-element filters a phase change of 90 deg., from 45 deg. to 135 deg., occurs over a frequency ratio of 3.732, nearly two octaves.

The three-element type produces a phase change of 90 deg., from 90 deg. to 180 deg., in just an octave, while complete phase reversal, from 45 deg. to 225 deg., takes a frequency ratio of 6.85, between two and three octaves.

The four-element filter produces 90 deg. phase change in a frequency ratio of only 1.38, less than half an octave; 180 deg. phase change, from 90 deg. to 270 deg., takes a frequency ratio of 3.08, between one and two octaves, while it passes through three right angles of its ultimate four in little over a decade.

Visualize what happens to a composite signal using four-element filters. At crossover, both units must be acoustically near enough in phase, to avoid undesirable dissociation or cancellation effects in this vicinity. The ultimate low- and high-frequency energy from their respective units will be in phase, but both in anti-phase with energy from both units at crossover. Taking in the whole spectrum view, then, the whole band is in phase except for a range of frequencies near crossover in which phase reversal takes place. So a wavefront composed of a wide range of frequencies will probably have just one of those frequencies completely reversed in phase. If the initial transient is free from coloration, reversal of this one frequency will produce a pronounced ripple on the wavefront at its own frequency, making the transient noticeably colored. This will happen, although steady-tone response of the composite arrangement may be as straight as a line drawn with a ruler.

Choice of filter arrangement will depend on application. If both loudspeaker units have a good response, and overlap somewhat, there is no need whatever to have a filter using more than one element in each section. If each unit is listened to separately, it may seem that

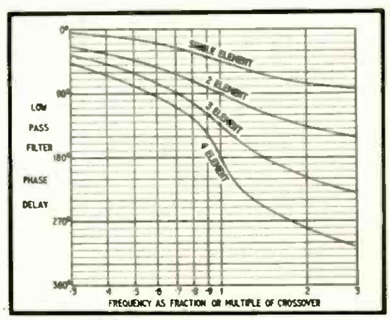

Fig. 9. Comparison of the phase response for filters using from one to four elements. Response for the low-pass section is shown. That for the high-pass section is similar.

the "die" beyond crossover is rather too gradual. But listen to the two units together. If their sensitivities are about equal, even with single-element filtering, the frequency does not have to be far removed from crossover for a very definite impression to be formed as to which unit is delivering apparently all the sound. The unit receiving the greater proportion of energy at a particular frequency will always mask the other one, provided the other is not producing any distortion.

For cases where the acoustic cut-off necessitates more rapid reduction in energy fed to the high-frequency unit, the two-element filter will usually be adequate. It is true that acoustic cut-off can exceed the ultimate slope of 12 db/octave, but this aspect may be safeguarded by moving crossover a little farther from the acoustic cut-off, so as to allow a margin. This will also ensure that signal amplitudes sufficient to damage the h.f. unit (below cut-off) do not reach it.

Intermodulation

As well as providing more uniform coverage over a wide range, one of the advantages of using separate units for different parts of the frequency spectrum is the avoidance of intermodulation distortion. In its commonest form, this is the modulation of h.f. tones by large amplitude l.f. tones, producing a "dithery" effect in the reproduction. By feeding the l.f. tones to a large unit designed to handle them comfortably, and the h.f. ones to another equipped specifically for responding to their more rapid vibrations, intermodulation distortion due to loudspeakers is largely avoided.

While loudspeakers can introduce much more intermodulation distortion than a respectable amplifier, no amplifier is completely free from this form of distortion. For this reason, some experimenters prefer to separate the frequency bands before final power amplification, using an individual power amplifier to drive each loudspeaker unit. Channel filters of this type should have attenuation and phase responses similar to the crossovers used in loudspeaker circuits, but the impedance at which they operate will be quite different. They can more readily be correctly terminated, and efficiency is not so important, as they will not be absorbing precious output power.

Filters for this application use more convenient capacitor values, but the inductance values come out rather large for high-impedance circuits. Inductances for use at low levels are also prone to pick up supply ripple or hum. Both these objections may be overcome by using negative feedback in conjunction with suitable capacitor values. Design for circuits of this type to give attenuation and phase responses with the same properties as those developed in this article, will be presented in a future article.

THE PIANO

(from page 30)

Hence, the bass bridge is usually made in the form shown in cross section in *Fig.* 8. The extension strip is also made of wood and extends in the direction toward the center of the soundboard. Slight as this distance may appear to be, it does seem to improve the tone of the piano to some extent. at least in the bass register.

A further refinement is to have the length of string from the bridge to the hitch pin be a simple fraction of the longer vibrating portion, such as perhaps one-tenth. It is felt that this small segment helps to accentuate some of the higher harmonics of the string; this may be particularly true of the highest treble strings.

After the bridges have been glued, the soundboard, complete with bridges and ribs, is solidly glued into the frame or rim. It therefore acts as a diaphragm rather rigidly clamped around its edge. When struck with the fist, it emits a dull boom somewhat like a bass drum.

At this point it may be well to point out that in time a soundboard may crack along the grain, but this has practically no effect on the tone. If the crack is such that the two edges of the wood rub against one another and produce a buzz, the crack can be widened out with a gouge. A tapered strip of spruce wood can then be coated with glue and inserted in the crack; after the glue has hardened, the excess wood can be removed. This, however, is mainly done to improve the appearance of a grand piano, where the soundboard is visible; it is hardly necessary in the case of an upright piano. However, if the crack enlarges sufficiently, that section of the soundboard will pull away from the ribs and bridges, causing rattles.

Much more serious is the separation of bridge or one or more ribs from the soundboard. This is repaired with difficulty, if at all, and an entire new soundboard may be necessary.

After the soundboard has been glued into the frame, the cast-iron plate is set in place and screwed to the frame and supporting members by means of lag screws. Then the plate is strung, as many as four per man per day, yes—by hand. The strings are then rough-tuned by being "chipped" (plucked), and are then set aside to age. Although the strings are not strained beyond their

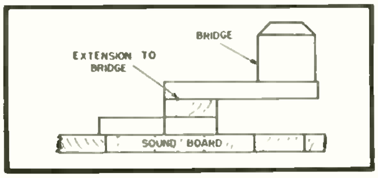

Fig. 8. Showing how the bridge is extended closer to the center of the soundboard.

elastic limit, they nevertheless stretch or yield somewhat at first, and have to age awhile before further tuning.

In the meantime the keys and action are installed and carefully regulated, then more accurate tuning is performed, and the hammers "voiced," as will be explained. The case is carefully stained and varnished or lacquered, but in the case of some manufacturers, the final coat is not put on until just before the piano is ready to be shipped to the store or home. The reason for this is that it has been found that if hardened lacquer or varnish is shipped through cold climates, in an unheated freight car, the finish tends to "cold check" or crack. A fresh coat of lacquer or varnish, however, is still soft and flexible even when dry, and prevents such checking. Moreover, it tends to freshen up the finish and appearance of the piano, for it takes over a year to manufacture and season a fine grand piano.

THE ACTION.—One of the main features of a piano is its action, or the mechanism that links the keys with the felt hammers that strike the strings. Most actions today are very similar, although the action for a grand piano differs noticeably from that of an upright or of a spinet. In a grand, the hammers return to their initial positions owing to the force of gravity and rebound; in an upright or spinet, a spring is required for this purpose. The result is a somewhat more sluggish response, and the action of a grand is considered much superior by a good artist. Owing to space limitations, however, we shall study only the action of a grand; to a musician, this is the only piano, anyway.

Figure 9 shows the action used in a

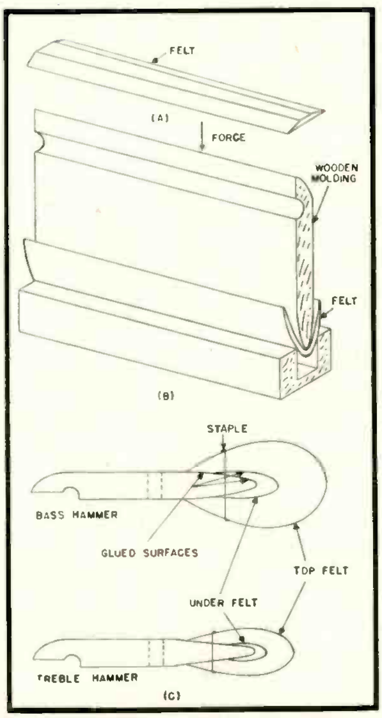

Fig. 10. Felt hammers and their construction.

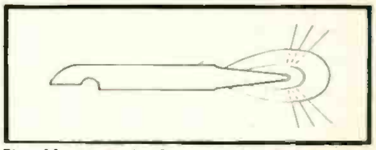

Fig. 11. Method of voicing by "pricking" a hammer.

Steinway Grand piano. The key **42** pivots on the half-cylinder or balance-rail bearing **63**. When pressed down at the front end, its rear end rises, and in particular the capstan screw **32** presses against support or "wippen" **24**, causing it to pivot on support flange center **30** and rotate counterclockwise.

As it does so, it raises the balancier or repetition lever **10** through support top flange **11**, but particularly it raises fly **19**, which works in a slot in balancier **10**. The fly pushes against knuckle **5** and forces it and the hammershank **4** up, along with the hammer **1**. As is evident from the figure, these pivot on hammershank center **8**.

The key can descend a minimum of about 3/8 in. whereupon it hits front pin punching **70**. By this time fly **19** has lifted the hammer until it is within 1/16 in. of the string from an initial position 1¾ in. from the string. This is as far as the fly can push the hammer, for tender **71A** strikes regulating button **43**, and causes the fly to rotate slightly clockwise and thus get out from under the knuckle **5**.

The hammer flies up to hit the string because of its inertia, and bounds back, where it is caught by backcheck **33**, covered with felt **34** and leather **35**. The knuckle **5** rests on repetition lever **10**, which is pressed upward about its center **12** by repetition spring **13**. If, now the key is raised but slightly so as to break contact between **71A** and **43**, fly **19** will be pulled back under knuckle **5** by spring **22** so that it can flip up the hammer once more if the key is depressed again. In short, if the same note has to be repeated rapidly, the key need be raised but slightly from its depressed position, so as to give the fly chance to get under the knuckle once more, and the slight depression of the key from this point will cause the hammer to strike the string once again.

At the rear, the key strikes underlever **48**, which raises damper wire **56**, damper head **57**, and damper felts **58** from the string just before the hammer hits the string (or strings). When the key is released, the damper falls down on the strings and stops the tone. On the other hand, if the key is kept depressed, the tone continues until all the energy in the string has been dissipated in internal friction in the soundboard and in acoustic radiation. (The action of the pedals will be discussed later.)

One thing should be evident from this simplified discussion of the action; the fly cannot be permitted to press the hammer against the string, otherwise the hammer would damp the string after actuating it. Instead, the hammer must proceed on the last part of its journey by itself, so that it can almost instantly rebound and thus allow the string to vibrate freely by itself.

The action is made of wood (such as pine for the keys and maple for the Action Parts), German silver pins for pivots, steel screws, cast iron, bronze, aluminum, or die casting action hanger 74, and bushing cloth tubes around the pivot pins to act as bearings. At first glance the construction might seem medieval, but the long trouble-free operation of this unit speaks eloquently for the fundamental soundness of its design.

It requires no lubrication; the cloth tubes glued into the holes in the wood act as excellent bearings. They are quiet yet free-acting, and, as stated previously, long lasting.

Another point of interest is Steinway's so-called accelerated action. In most other actions, the key rocks on a flat disc of felt. In the accelerated action, it rolls on the half-cylinder or balance rail bearing 63 in *Fig.* 9. This is Patent No. 1,826,848 issued to F. A. Vietor, a great-grandson of Henry. Mr. Theodore Steinway said that tests indicated it to be about 15 per cent faster than the older action, although the latter was so fast that only a finished artist can notice the difference.

Take such an item as the ivory overlay on the white keys. Although plastic overlays are available and used on the cheaper pianos, such as spinets, neither Steinway nor Baldwin, for example, would consider using them on their grand pianos, particularly their 9-foot concert grands. (Steinway uses ivory on *all* pianos, grands and verticals). The reason is that artists consider ivory cooler to the touch, and also as having less friction, even under strong pressure from the fingers, than plastic.

Engineers may question this contention as another manifestation of the emotional illogic of musicians. Certainly ivory is getting scarcer every day, and eventually plastic will have to be used; perhaps some new ivory may be obtained from synthetic elephants. Yet artists appear to be able to tell the difference between ivory and plastics, and sincerely prefer the former. On the other hand, Steinway no longer uses ebony for the black keys, but instead, a transfer-molded phenolic. This, Steinway feels is as good as ivory or ebony, if not better, but unfortunately does not come in a white color. But Baldwin still sticks to ivory and ebony.

The Hammers

We now come to the hammers. These are made as an entire group, as illustrated in *Fig.* 10. In (A) is shown a long strip of felt, cut in a jig with a sharp knife to the tapered shape shown. The felt is of special quality wool, and the manufacturers are rather proud of their product. The narrow end will be for the treble hammers; the wide end, of course, for the bass hammers.

Actually there are two layers of felt, as indicated in the finished hammers shown in (C). One is the under felt, over which is glued a top-felt. Some piano makers use only top-felt, but most feel that the under felt acts to add more resilience to the hammer.

The felts are coated with glue along their edges, and a long wooden molding placed on them, as shown in (B). The assembly is forced into a form in a press, and the heavy felt is literally folded around the wood and pressed tightly against it. When the glue is hard, the assembly is removed from the form, and sawed apart into the 88 hammers forming a set for the piano. Owing to the taper in the felt and in the wooden molding, the heaviest keys are at the bass end, and the lightest at the treble end, as is clearly indicated in (C). The felts are then wired through the wooden shank, as shown, and the wire is twisted together on the far side.

Note that the felt is not glued along its most rapidly curving inner portion, but only along the sides. This somehow is supposed to improve the tone by eliminating brittle glue, although primarily the tone is determined by the nature of the outer surface.

If the outer surface were hard, like a metallic surface, for example, the tone would be sharp and clanging, because of the sharp deformation produced in the string upon striking it—the deformation itself denotes stronger higher harmonics. On the other hand, if the surface is too soft the string develops mainly a fundamental tone with some of the lower harmonics, and the tone sounds muffled.

Hence, by proper preparation of the felt surface, the tone may be rendered sharp or mellow; that is, the piano may be "voiced." The men that do this are experts, and their hearing is better trained for that particular type of tone than that of most artists. In voicing a new piano, they may pick a key which they feel represents the quality they desire. Then if some other key has too "mushy" a tone, they will file (sandpaper) off a layer of the felt to expose a harder layer underneath, and thus render the tone more brilliant.

On the other hand, if another key has a tone which is too metallic or "twangy," the voicer will "needle" the felt. This is done by piercing the felt radially with needles as illustrated in *Fig.* 11; note, however, that the striking surface is not pierced. This treatment serves to produce a soft bed under the harder layer of felt that strikes the string. Usually the needling is done by a wooden tool having three needles protruding about ½ in. from it, so as to produce several holes at once. A single long needle may also be used to even out the tone when the key is pressed down hard: this is known as taking "deep stitches."

Hammers in use for many years tend to have the striking faces of the felts flattened, as well as grooved by the strings. Such a hammer does not rebound cleanly from the string and hence tends to damp the string it just set into vibration. The upper harmonics in particular, suffer. Hence, the felts have first to be filed into an elliptical shape once more, and then voiced as required. Voicing is a long, tedious, exacting, and expensive process.

MISCELLANEOUS CONSIDERATIONS.—*Figure* 9 indicated that the action is quite a complicated mechanism and that there are numerous screws and parts for the purpose of adjustment. The key, it was mentioned. is permitted to descend a minimum of 3/8 in. The capstan screw rises about half this distance, indicating a 1:2 lever arm. However, the hammer moves a distance of from 1¾ in. to 1⅞ in. when the key is fully depressed; this is five times the distance that the front end of the key moves. Hence the over-all lever arm is 5:1.

Adjustments are made to the various screws, and by the use of paper shims under the keys, etc. The keys, when not depressed, must all be of the same height, although actually the surface is slightly arched in that the middle keys are about 1/32 in. higher than the end bass and treble keys. This is to compensate for the greater matting of the felt washers in the action in the middle range, where most of the playing occurs. The hammers should all lie on a straight line, and they should "let off" from the fly or jack when they are about 1/16 in. from the string.

In a grand the keys spring up because of the weight of the action and hammers on their back ends. Hence, the force the finger must exert on the front end of the key depends upon this weight. The force can be decreased by balancing the rear weight with lead weights inserted into the front sides of the key, as indicated by the dotted circles in *Fig.* 9.

If the counterbalancing is appreciable, the piano is "easy" to play, but has some disadvantages. In the first place, the mass of the moving parts has been increased, and the restoring force has been decreased, so that the action becomes sluggish. In the second place, human muscles can control motions better if there is some opposition to the motion rather than if there is none. Finally, for practice purposes a "stiffer" action is preferable. The above discussion does not consider frictional opposition; if the action is properly constructed, the frictional forces should be negligible.

Part 2 of this article, covering theoretical considerations of the instrument, will appear next month.

XD SPEAKER

(from page 38)

of tests, carried out prior to the ones above, indicated that true stereophonic rendition could be less easily simulated by reproduction of a single-source program—fed in identical fashion to two speakers—than by listening to the same two speakers, each with a different frequency balance. This was to be expected because, next to independent phase detection by the left and right ear, one of the important characteristics of stereophonic sound is the potential difference in spectral composition between the sound radiated from the reproducing speakers. It should be noted that from here on, instead of the double track recordings, the normal single track records were used.

The Finished Product

Encouraged by these experiments, a simple and inexpensive system was tried which resulted in the new Columbia XD system. The Columbia "360" player was launched at a time when the final design of the XD system was not yet frozen. Thus the "360" cabinet was provided with a jack in the back which later was to accommodate the XD speaker. This was not just another speaker but part of the over-all simulated stereophonic system identified as the XD (Extra Dimensional) sound.

The frequency characteristics of the "360" itself and of the separate speaker have been so fashioned that, when plugged in, the jack of the external speaker causes a roll-off of the highs and emphasis of the lows in the "360" player. At the same time, the external speaker assumes the required opposite characteristic; namely, emphasized highs and attenuated lows, exactly as determined in the previously described tests.

In order to conceal the identity of the box and at the same time to give it added utility, the extra speaker is housed in a small cabinet—a 7-in. cube—so designed that it contains an electric clock. Sound is radiated from a 6-in. speaker, which is the same type as used in the "360", through louvres inclined at 45 deg. located on the top of the box. The sound is thus deflected against the wall behind the speaker, thereby providing a diffused distribution of the higher frequencies in that area of the room. The separate speaker of the XD system should preferably be placed in a corner diagonally opposite the "360" player to give most effective results in the average room. Naturally, there are other arrangements possible, depending on the particular layout of the room.

Figure 2 shows the external appearance of the XD speaker and *Fig.* 3 is a schematic of the "360" and the external speaker. *Figure* 4 shows the amplitude characteristic of the "360" with flat signal generator input measured across the speaker terminals without the extension speaker plugged in. *Figure* 5 shows the altered response of the "360" itself with the XD speaker plugged in (dotted curve) and the frequency characteristic of the XD unit itself measured across the speaker (solid curve). There is an intensity control in the back of the XD speaker which permits balancing of its output with respect to the main instrument.

When the XD speaker is plugged into the "360", the effect on the listener is quite startling. Broadening of the sound source is immediately apparent, even to the point that the positions of the two speakers are detectable only after careful scrutiny. There is a distinct impression of spatial dispersion which is lacking in conventional single- or dual-speaker sound systems.

AMPEX REMOTE CONTROL

(from page 23)

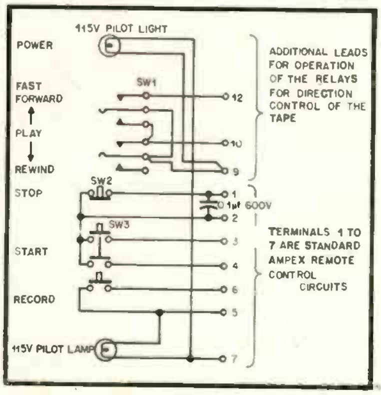

Fig. 4. Wiring of complete remote control box. Upper portion shows new lever switch, while lower portion shows normal Ampex remote control circuit.

held down while the lever switch is slowly thrown into the PLAY position from either other position the tape will be broken. In the regular rotary switch operation the tape would break when the START button was held down when switching from REWIND to PLAY. A slight inconvenience in using the new lever switch is that during rewind and fast-forward operation the lever must be held in the proper position.

Remote Recording

To record from the remote positions,

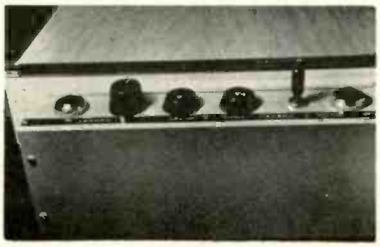

Fig. 5. Remote control box assembly.

the recorder monitor output ahead of the monitor switch output is brought out to an existing supervisory speaker at each remote point. Being able to listen to the output of the tape brought up the question of how to determine when the tape was at the recorder head and also when to stop rewinding. This was solved by previously recording about ten seconds of a 400-cps tone at the very beginning of the tape.

Figure 4 is a schematic of a typical remote control assembly. *Figure* 5 shows the external appearance of the remote

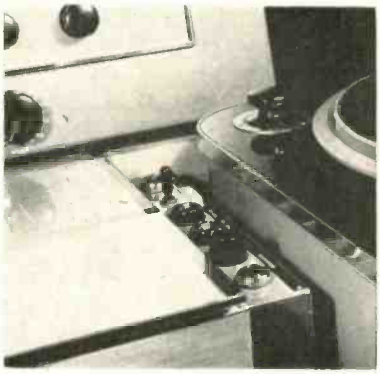

Fig. 6. Remote control box in place in one of the control rooms.

control box, which is also shown in a typical position in *Fig.* 6 alongside one of the audio consoles. The new remote switch is shown in detail in *Fig.* 7.

Several months of operating this tape recorder "blind" from two remote points have proved that the change was well worth the effort and expense involved. The author is indebted to Mr. Kohlbrenner, of the WGR Shop, for the construction work done on this modification.

Parts List

- *Sw_1* Cam lever switch—General Control Company type MCM frame, contact forms 2-F
- *Sw_2* H & H push-button switch, normally closed. (stock Ampex part)
- *Sw_3* H & H push-button switch, DPST normally open. (stock Ampex part)
- *Sw_4* H & H push-button switch, SPST normally open
- *E_1* Advance relay type 979B 3PDT, break 3 and make 3 contacts; coil—115-v. a.c., 60-cps.
- *E_2* Advance relay type 953B SPST; coil—115-v. a.c., 60-cps.

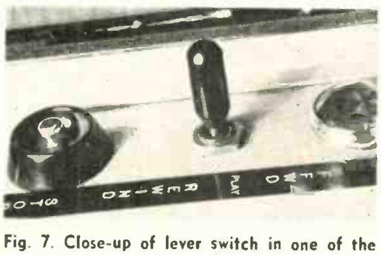

Fig. 7. Close-up of lever switch in one of the remote control boxes.

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.

CORRECTION: Fairchild Recording Corp.
In the August column, Model 201-B Three-Way Turret Head was reported as discontinued. It was actually replaced by Model 202 Three-Way Turret Head at $65.00 net.

Recording Equipment, Speakers, Amplifiers, Needles, Tape

BRUSH ELECTRONICS—Discontinued Model BA-116 Microphone.
EICOR—Added Tape Recorders Model 230 at $110.47 net; Model 400 at $83.65 net.
FISHER RADIO—Increased price on Model 50-R FM-AM Tuner to $164.50 net.
OXFORD ELECTRIC—Added loudspeaker Model HF15LN at $25.50 net.
PRESTO RECORDING—Added several new Lacquer Coated Aluminum Discs.
REK-O-KUT—Added Model C-12H Carrying Case for Model T-12H 12" Turntable at $26.95 net.
RIVER EDGE INDUSTRIES—Added Model 720 at $25.50 net and Model 730 at $9.90 net to their Hi-Fi and TV Cabinet series.

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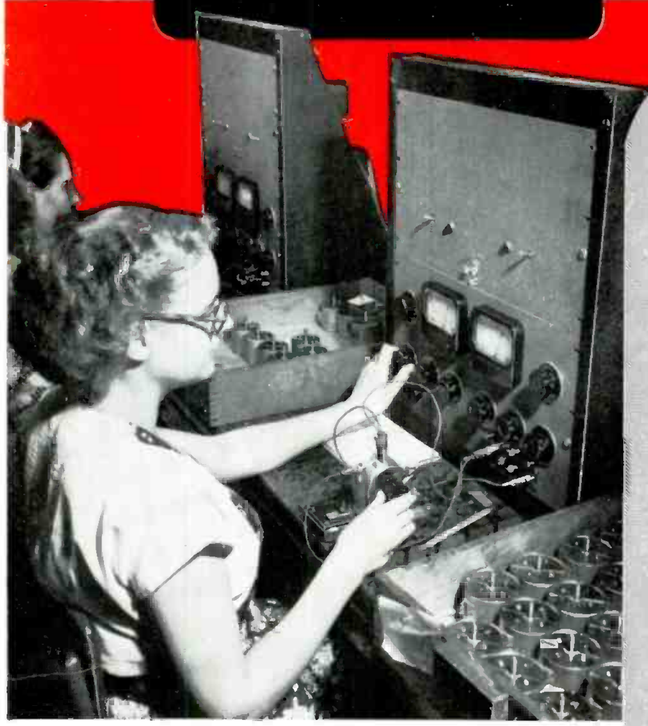

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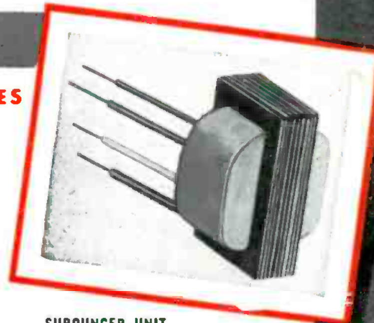

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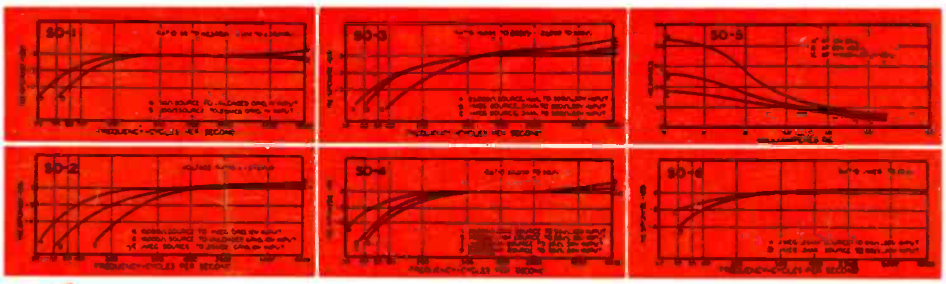
Dimensions....9/16" x 5/8" x 7/8"
Weight .... .03 lb.

UTC Sub-Ouncer units fulfill an essential requirement for miniaturized components having relatively high efficiency and wide frequency response. Through the use of special nickel iron core materials and winding methods, these miniature units have performance and dependability characteristics far superior to any other comparable items. They are ideal for hearing aids, miniature radios, and other types of miniature electronic equipment. The coils employ automatic layer windings of double Formex wire . . . in a molded Nylon bobbin. All insulation is of cellulose acetate. Four inch color coded flexible leads are employed, securely anchored mechanically. No mounting facilities are provided, since this would preclude maximum flexibility in location. Units are vacuum impregnated and double (water proof) sealed. The curves below indicate the excellent frequency response available. Alternate curves are shown to indicate operating characteristics in various typical applications.

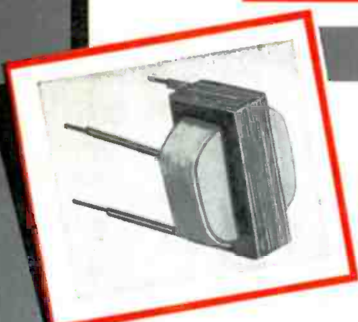
Type	Application	Level	Pri. Imp.	D.C. in Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	16	2650	$6.50
SO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	225	1850	6.50
*SO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 mil. 1.5 mil.	200 500	1300	30	6.50
SO-4	Output	+ 20 V.U.	30,000	1.0 mil.	50	1800	4.3	6.50
SO-5	Reactor 50 HY at 1 mil. D.C. 3000 ohms D.C. Res.							5.50
SO-6	Output	+ 20 V.U.	100,000	.5 mil.	60	3250	3.8	6.50

*Impedance ratio is fixed, 1250:1 for SO-1, 1:50 for SO-3. Any impedance between the values shown may be employed.



SUB-SUBOUNCER UNITS

FOR HEARING AIDS AND ULTRA-MINIATURE EQUIPMENT

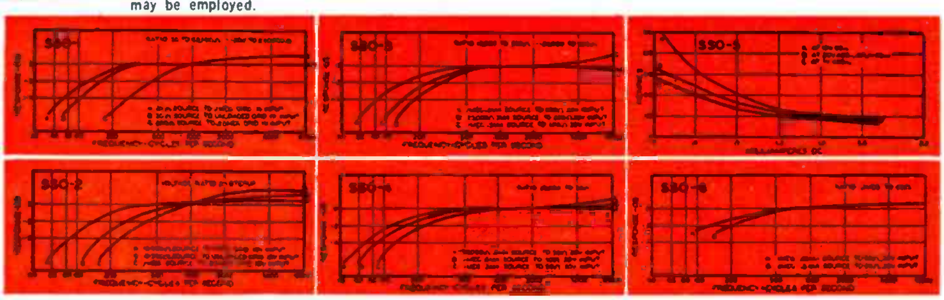


SUB-SUBOUNCER UNIT
Dimensions....7/16" x 3/4" x 5/8"
Weight .... .02 lb.

UTC Sub-SubOuncer units have exceptionally high efficiency and frequency range in their ultra-miniature size. This has been effected through the use of specially selected Hiperm-Alloy core material and special winding methods. The constructional details are identical to those of the Sub-Ouncer units described above. The curves below show actual characteristics under typical conditions of application.

Type	Application	Level	Pri. Imp.	D.C. In Pri.	Sec. Imp.	Pri. Res.	Sec. Res.	List Price
*SSO-1	Input	+ 4 V.U.	200 50	0	250,000 62,500	13.5	3700	$6.50
SSO-2	Interstage/3:1	+ 4 V.U.	10,000	0	90,000	750	3250	6.50
*SSO-3	Plate to Line	+ 20 V.U.	10,000 25,000	3 mil. 1.5 mil.	200 500	2600	35	6.50
SSO-4	Output	+ 20 V.U.	30,000	1.0 mil.	50	2875	4.6	6.50
SSO-5	Reactor 50 HY at 1 mil. D.C. 4400 ohms D.C. Res.							5.50
SSO-6	Ouptut	+ 20 V.U.	100,000	.5 mil.	60	4700	3.3	6.50

*Impedance ratio is fixed, 1250:1 for SSO-1, 1:50 for SSO-3. Any impedance between the values shown may be employed.



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