AUDIO ENGINEERING

May
1952
35c

Hi-Fi
Cabinet Design
see page 26

THE WORLD OF SOUND

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

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

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

AUDIO DEVICES, Inc.

444 MADISON AVE., NEW YORK 22, N. Y.
Export Dept.: 13 East 40th St., New York 16, N. Y., Cables "ARLAB"

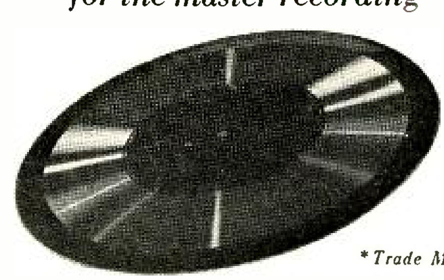
...including

audiotape*

for the original sound

...and **audiodiscs***

for the master recording



*Trade Mark

Successor to RADIO —Established 1917

AUDIO ENGINEERING

INCLUDING VIDEO ENGINEERING

C. G. McProud, Editor **Ladd Haystead, Publisher**

Harrie K. Richardson, Associate Editor
Luci Turner, Production Manager S. L. Cahn, Advertising Director
Lucille Carty, Circulation Manager H. N. Reizes, Advertising Manager

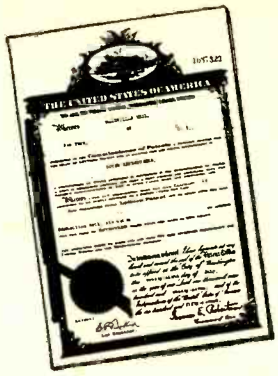
CONTENTS MAY, 1952 Vol. 36, No. 5

COVER

Yes, you are right—its Pops himself, engaged in discussion with Frank Marx, fellow vice-president of the American Broadcasting Company. Although Marx heads up engineering, and Mr. P. W. is veep in charge of music, they find a basis of compatibility in the many years both have spent in the audio field. This picture, taken especially for Æ, commemorates the opening of ABC's magnificent new Radio Center in New York.

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

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at 10 McGovern Ave., Lancaster, Pa., by Radio Magazines, Inc., D. S. Potts, President; Henry A. Schober, Secretary-Treasurer. Executive and Editorial Offices: 342 Madison Avenue, New York 17, 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*

INTERCOMS are among the most useful of the products conceived by the audio industry, but almost every engineer or technician who has ever had to do with intercom systems has felt a sense of guilt over the fact that in the usual system the operator must press a key to talk and release it to listen. The handicap to business people who use intercoms is even greater, of course, for the talk-listen switch takes one hand out of circulation even more effectively than using the telephone; the latter, at least, can be held on one shoulder, assuming a certain amount of dexterity or one of the gadgets sold for the purpose.

A number of ideas have been proposed for doing away with the switch, not many of which are especially practical, either because they involve critical adjustments or require expensive special components. William A. Plice is the latest inventor to be granted a patent on a switchless intercom, but his idea appears to be more practical than most, involving only one extra amplifier stage and an extra output transformer. The patent is numbered 2,577,806.

The system is suitable for systems with any number of stations, since adjustment affects only circuits within one unit and is independent of line length, capacitance, and the characteristics of the other units. A two-station system using Plice's invention is block-diagrammed in *Fig.* 1. The system involves a loop connecting the input of each amplifier to the output of a special "selector network," one amplifier and one selector network being used at each station. As the block diagram appears on the surface, the circuit ought to howl like a banshee. It does not, however, for while the output of each amplifier goes through the selector network to the speaker and the output of the speaker as a microphone goes through the selector network to the other amplifier, there is little or no signal directly transferred between input and output of the selector network. Thus, for "loop" signals, the loop is effectively broken by the networks.

Figure 2 indicates in schematic form just what happens. One of the amplifiers is shown, with its standard input and output stages; its gain is around 35 db and it is entirely conventional. The selector network is drawn completely, with its 6F6 (or similar tube).

The amplifier output transformer is normal except perhaps for its secondary impedance and the fact that the secondary must carry the plate current of the 6F6. "B" voltage is fed through the secondary and R_1 to the 6F6 plate. The signal in the secondary goes through C_1, a large-value blocking capacitor, and appears at grid No. 1 of the 6F6. This is the signal received from the other station at the input of the amplifier (and amplified).

The voltage at the network output terminals B (between 6F6 plate and ground) is equal to the source voltage in the amplifier output transformer secondary less the voltage drops in R_1 and the effective internal resistance of the source due to a.c. 6F6 plate current. The grid No. 1-to-plate amplification of the tube is adjusted, with R_1, so that the resultant network output voltage is zero, or at least repre-

[*Continued on page 4*]

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

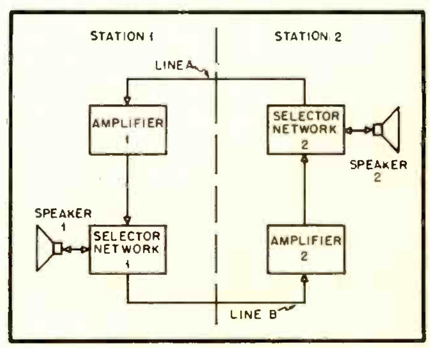


Fig. 1

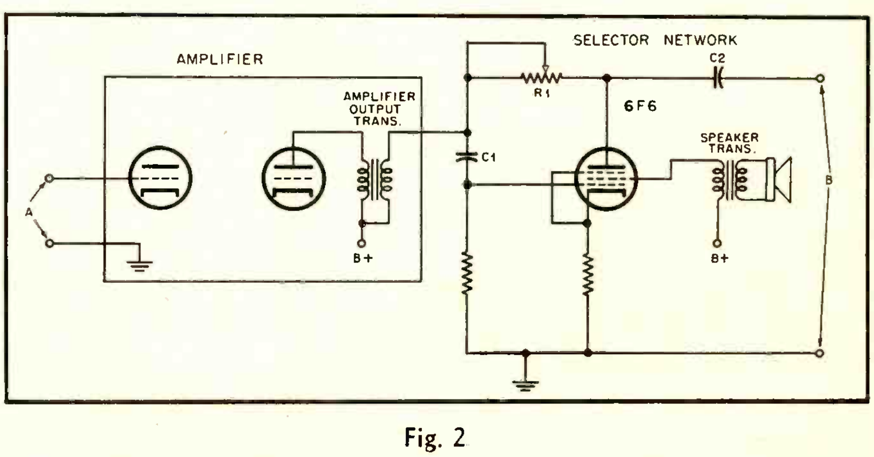
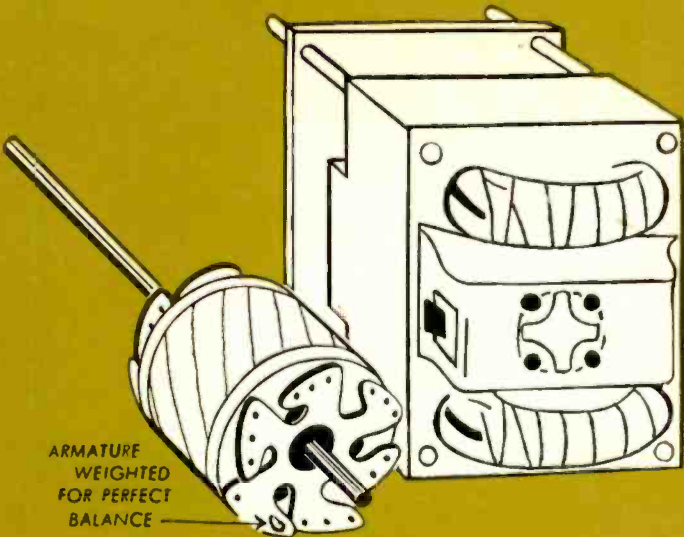


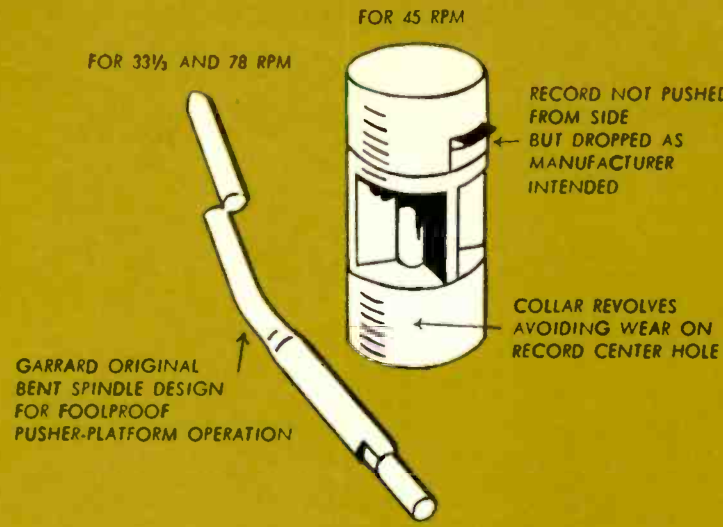
Fig. 2



★ *4-pole heavy duty motor*
with armature balanced in operation...

because only a 4-pole motor can eliminate hum induced by stray magnetic fields when sensitive pickups are used and because only a dynamically balanced armature can guarantee genuine rumble-free motor performance.

Of course, the Garrard has a 4-pole motor with dynamically balanced armature, assuring greater smoothness and more even power.



★ *Interchangeable spindles...*
one for 33⅓ and 78 rpm; another for 45 rpm

because records should be played as the manufacturers intended, adding to record life and resulting in greater convenience for you. No need to "stock up" and "plug up" with spiders.

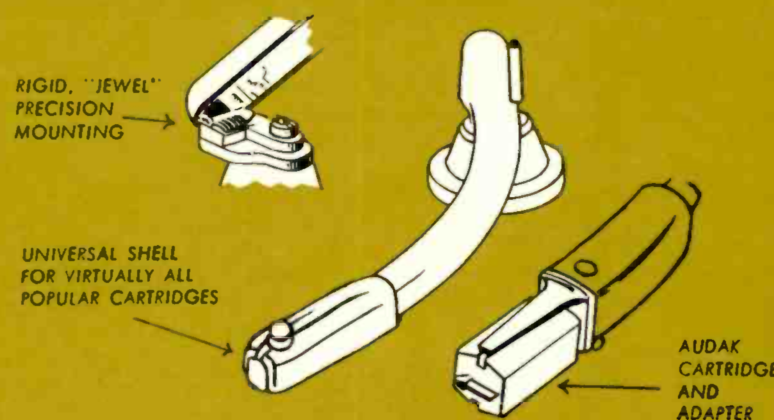
Of course, the Garrard provides both spindles. In fact, Garrard was the first record changer to feature the bent spindle design, which has been so widely imitated.

What to look for in a record changer...

★ *Weighted turntable...*

because only a weighted turntable provides the "flywheel action" which helps to eliminate wows and wavers. When the turntable is driven along a precision-built drum, as in the Garrard, instead of along the rim, as in ordinary changers, you avoid "flutter" and uneven speed.

Of course, the Garrard quality turntable is heavily weighted and scientifically balanced. See for yourself and compare! — Ask to lift and examine the Garrard turntable at any sound department.



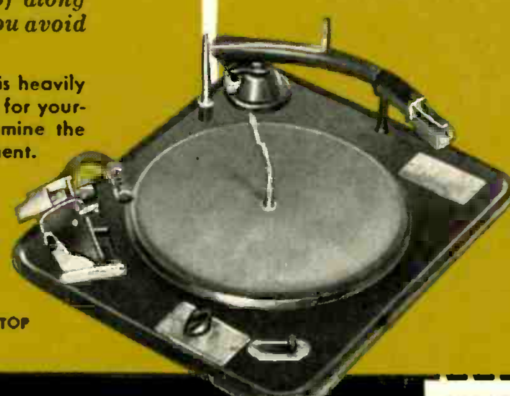
★ *"Jewel" mounted, non-resonant tone arm*
with plug-in universal shell...

because tone arm "drag" or poor stylus tracking will damage your records from the very first playing and because a pickup shell which accommodates all the popular crystal and magnetic type cartridges, including Audak, Pickering and GE twist models, will enable you to satisfy your own preferences regarding cartridges.

Of course, the Garrard tone arm is precision-mounted to provide genuine floating response. And Garrard supplies you with 2 universal pickup shells for the cartridge of your choice — now and in the future.

Imitated But Never Equalled

HEAVY DUTY SILENT MOTOR • PULL-AWAY IDLER WHEEL
INTERCHANGEABLE PLUG-IN HEADS • HEAVY DRIVE SHAFT
WEIGHTED TURNTABLE • "JEWEL" MOUNTED TONE ARM
PUSHER TYPE PLATFORM • MUTING SWITCH • AUTOMATIC STOP
TWO INTERCHANGEABLE SPINDLES



GARRARD
THE WORLD'S FINEST RECORD CHANGER

GARRARD SALES CORP. Dept. SE.
164 Duane St., New York 13, N. Y.

Dear Sirs:
I am interested in learning what to look for when purchasing a record changer. Please send me your FREE FACT SHEET.

NAME________________

ADDRESS________________

CITY________________ZONE______STATE________ sents an amplifier input-to-network output gain of less than 1. Thus the voltage sent from the network to the other station has in it little or no component of the voltage transmitted by the other station and the 6F6 network breaks the loop and prevents feedback.

This adjustment, however, does not materially affect the grid No. 1 to grid No. 2 gain of the 6F6. The screen is operated as an anode for receiving purposes, drawing audio current through its speaker transformer primary which represents the amplifier output signal. When the speaker is used as a microphone the screen acts as a control grid and varies the plate current. This produces a resulting audio output across R_1, which is transferred along the output line B to the other station.

In the patent specification the inventor presents the formulas illustrating his design criteria, together with an equivalent circuit. To produce the desired results, he shows that the required value for R_1 is equal to the 6F6 plate resistance divided by the grid-plate transconductance. C_2 and the amplifier output transformer have been inserted by the writer; the inventor shows no C_2 and indicates only B-plus and amplifier signal at the junction of R_1 and C_1, but it appears that the practical method is probably as shown.

Organ Recording

John Hays Hammond, Jr. (not to be confused with Laurens Hammond of Hammond Organ fame) has for many years been an inventor of interesting devices, a great number of them concerned in one way or another with a mixture of electronics and music. His latest patent, No. 2,578,541, contains a touch of anomaly and a hint of controversy, which makes it interesting as well as ingenious.

Mr. Hammond points out that when the swell shutters of a standard pipe organ are closed to lower volume the reduction in high-frequency transmission from the organ chamber is reduced to a larger extent than low-frequencies. Though the writer has never noticed it, the thesis seems entirely reasonable since treble tends to approach line-of-sight propagation while bass will ooze out everywhere. Thus, goes on Mr. Hammond, when organ music is being recorded, there ought to be automatic treble equalization in the recording circuits to offset the loss of highs and keep the balance the same whatever the position of the swell shutters.

As a first thought this is reminiscent of a recent published amplifier circuit with automatic loudness control. The author of the article had designed a unit in which the lows (and probably the highs) were emphasized as the volume of the music went down. He blissfully stated that this was compensation for the Fletcher-Munson effect, entirely oblivious of the consideration that the Fletcher-Munson effect is not electronic but occurs in the concert hall as well as anywhere else; an orchestra naturally does not have the same balance at different volume levels and maybe the composers had that in mind (subconsciously at least) when they composed their works. The question is, does it improve organ music to have the balance the same at all levels, or does it make the instrument sound unnatural and defeat the aim of the composer?

This writer is quick to admit that there is no harm in improving a musical instrument, and since that very thing has been in process for hundreds of years—as witness the development of keyboard instruments up to the pianoforte just to cite one example—what is to stop someone from

[*Continued on page 43*]

audio techniques—

Improving Voice Recording with Organ Accompaniment

PAUL H. SEITZINGER*

On a number of occasions, the writer has attempted to record voices—either in chorus or solo—accompanied by an organ. The earlier attempts all resulted in unusable recordings in which a vicious form of intermodulation distortion was present. This was particularly annoying when low, powerful organ notes were mixed with the higher voices. The results were somewhat like the noise from the so-called rubber "razzes" that were available some years ago and which made a very in-dignified sound when blown into.

This trouble was at various times blamed on poor output transformers, inadequate power in the amplifier driving the cutter head, an overloaded cutter head, and anything else that was handy when the "blaming" took place. When finally a good magnetic recorder was procured, it was thought that the trouble was surely over. But it wasn't! In the recording of a wedding ceremony, the same trouble appeared in the organ music alone, without any voice. The fact that many other recordists had the same trouble was not sufficiently comforting. For the benefit of those who may still have trouble of this sort, this information is passed on to aid in its elimination.

The solution is simple and inexpensive, as is so often the case with perplexing problems. The answer began to appear after a few very "clean" recordings were made of a large choir and organ.

It was realized that all of the recordings with this distortion had been made with the microphone mounted on a floor stand which, of course, was standing on the floor. Now, as is well known, when any good organ really gives forth with the powerful bass notes, it will vibrate the floor or the entire building. This vibration transmitted up through the stand is of much greater intensity than any air-borne vibration (sound) reaching the microphone. This, then, seems to be the answer to the distortion.

The clean recordings were made with the microphone suspended from a length of sash cord stretched across the auditorium, the microphone hanging from the center of the cord which was about 75 feet long. The resonant frequency of the cord is such as to be below the audible range, and therefore effectively damps out any vibrations that might otherwise be transmitted mechanically to the microphone.

The clean quality of recordings made with this type of microphone suspension has been attested to by the entire staff of the Music Department of The Pennsylvania State College and most of the lovers of choral music recordings in this area. Other recordists have used this method with equally clean results.

It is possible that a "soft" mounting between the stand and the microphone would be of great help if the conditions prohibited the suspension of the mike from a sash cord and it became necessary to use a stand. Fortunately, the writer has been able to use the sash cord suspension on all recordings of this nature since the solution became apparent, and therefore has not made any tests with a soft-mounted microphone on a stand.

* *Coronet Instructional Films, Glenview, Ill.*

LETTERS

"Hole in the Wall" Again

Sir:

In campaigns—military, scientific, or any other—a plan often appears suddenly which shows a quicker and easier solution and eliminates great wastes of material and priceless time. One wonders, as he looks at progress in high fidelity, if P.G.A.H. Voigt's excellent "Hole in the Wall" concept ("A controversial idea from England," Æ, Oct. 1950) is not one of these great strategems. To me, at least, it left a plan of action in place of a rather shaky faith in audio perspective. Is audio perspective necessary for a feeling of "presence" in concert music? How much perspective does a concert-goer actually get from a back row at Hollywood Bowl, for example?

If we were to transport our living room to the same location in the Bowl and open our French doors to the orchestra, the sound arriving from the orchestra by direct route would be, for all practical purposes, plane wave fronts normal to an axis drawn through the doorway. We could place in the doorway a diaphragm of zero mass and suspend it at the edges with zero restoring force and expect to retain the original quality of sound inside the room because the diaphragm in this case would be acoustically transparent. In fact, it seems very probable that if we placed in the opening a structurally rigid diaphragm, driven by a distortionless driving system which is, moreover, compensated for the diaphragm's vibration characteristics, we would have the same feeling of transparency as long as we dealt only with the direct sound from the orchestra. Actually the usual location of the microphone for orchestra pickup, indoors or out, is very close to the orchestra, minimizing the indirect sound reaching the microphone by reflection. For this reason, when listening to our rigid diaphragm, we would be apt to feel that our listening room was located out of doors some hundred feet from the orchestra shell.

In agreement with this theory of transparency, we know that if in the real case we moved about in the room to a place where we couldn't see the orchestra through the French doors, we would notice a loss in high frequencies, characteristic of the beam effect of large radiators. It would be natural, then, for a listener to want to sit on the axis of the doorway where he could see the orchestra and hear the best. It would be a good idea, therefore, to build the French doors diagonally into the corner of the room so as to make more of the room's floor space usable for listening. (*Would it?* Ed.)

This sort of reasoning brings with it a desire for an "acoustic French door" which could be installed in the corner of a listening room. Banks of cone speakers do not lend themselves perfectly to such an installation because of the necessary separation of the unit causing irregularities at high frequencies. But possibly a large electrostatic loudspeaker could fill the requirement.

It is encouraging to read of the development at Harvard University of a practical electrostatic loudspeaker by Arthur A. Janszen, R. L. Pritchard, and F. V. Hunt. The development of the speaker is minutely described in a technical memorandum which shows plots of its extreme smooth frequency response and near-perfect transient response. The text shows how the difficulties which led to the virtual abandonment of the electrostatic principle have been overcome with new materials and new techniques.

It seems very likely that our most satisfactory reproducer may some day be an electrostatic loudspeaker, and also very likely it may assume the form of French doors through which to watch Handel's barge on the River Thames.

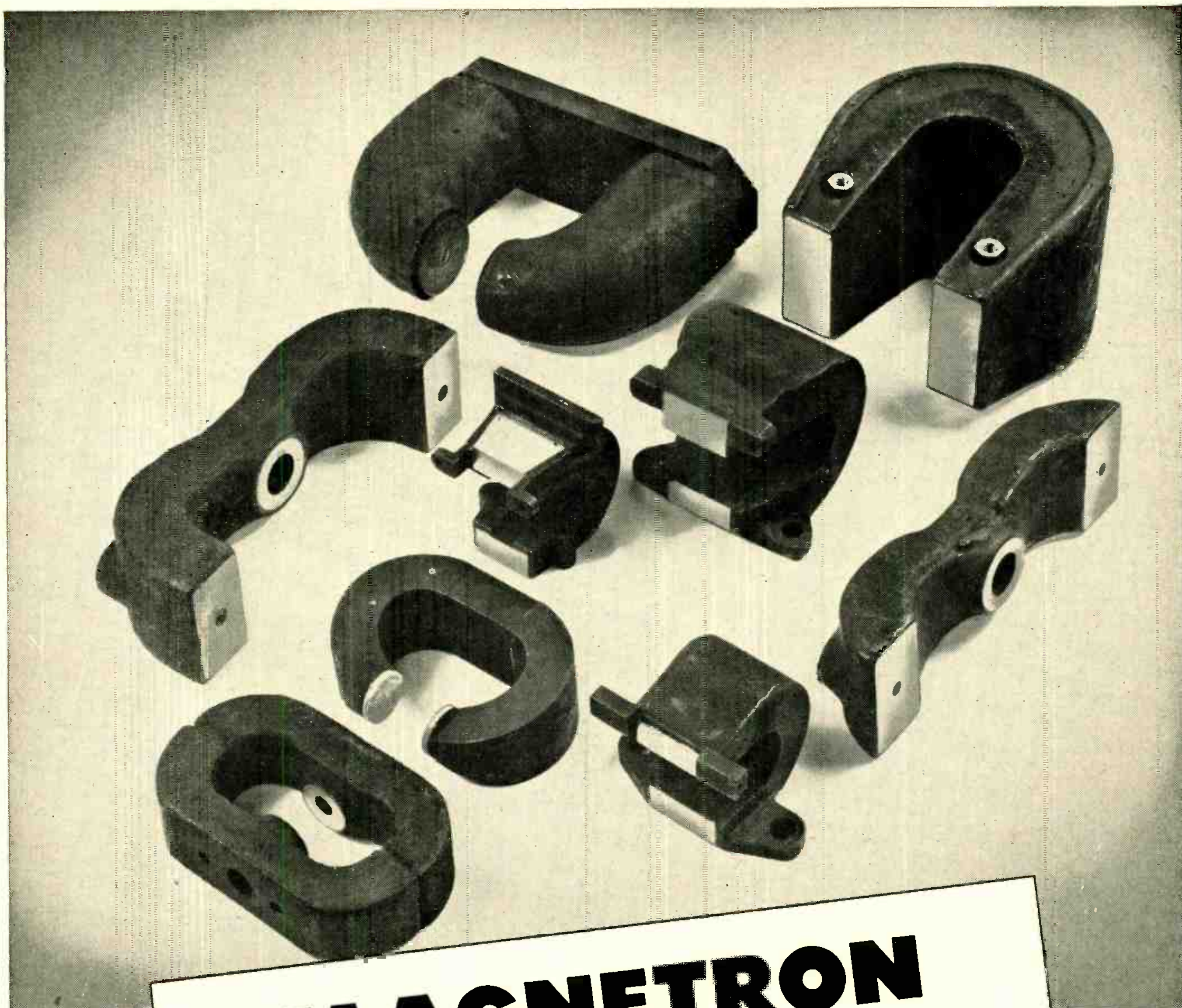
Vern Yeich,
39 E. Cassilly,
Springfield, Ohio

Loudness Control Philosophy

Sir:

The Toth article in the January issue has brought me around to thinking about the problem of compensation for the Fletcher-Munson curves again. When the "full-range loudness control" was first described, I dutifully built one and installed it in my

[*Continued on page 10*]



MAGNETRON
PERMANENT MAGNETS AND ASSEMBLIES

with

- ☆ **Die Cast Aluminum Jackets**
- ☆ **Sand Cast Aluminum Jackets**
- ☆ **Celastic Covers**

Complete assemblies with Permendur, steel or aluminum bases, inserts and keepers as specified. Magnetized and stabilized as required.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

LETTERS

phonograph. It has been in use now for about two years. It has become increasingly clear, however, that the most valuable part of this device is the "de-compensating" switch that makes it possible to remove the compensation that the control provides. After noticing how regularly I was cutting out the refinement that I had gone to so much trouble to provide, I was led to think over the problem with some care, and I have decided that all the engineering that has gone into compensating controls is based on a false assumption.

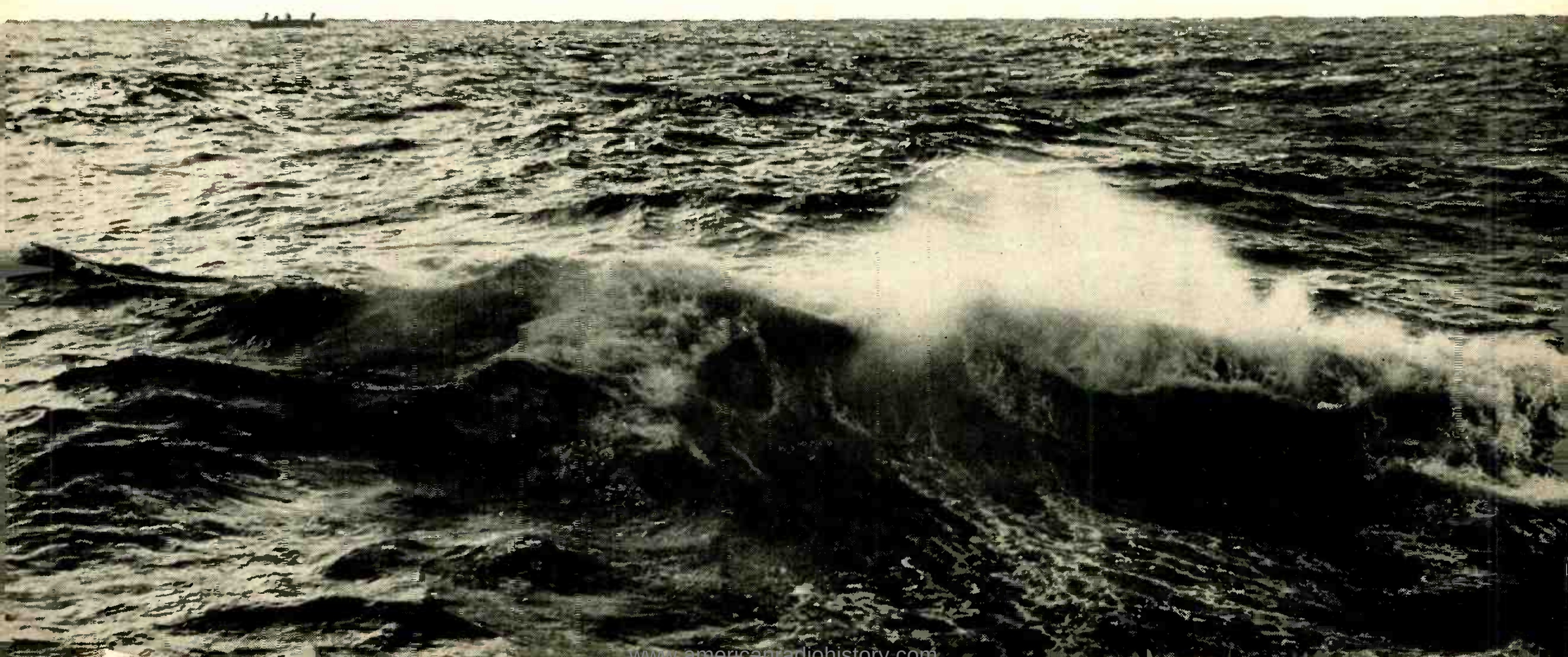
The point is this: when we reduce the level of our sound reproduction so that the sound reaching our ears at home is less than that we would hear in a good concert-hall seat, what we really desire is not a scaled-down-orchestra sound, but rather a full-size-orchestra sound as heard at a distance. Our experience of real music heard at a low level occurs when we have a back seat at the concert hall, or when we stand in the lobby, or at an outdoor concert. In any of these cases, the sound reaches our ears at low intensity and we hear the decline in bass that results from the Fletcher-Munson effect. This is exactly what we want when we turn down the volume at home. Compensation results in a situation that does not occur in "real life," for we hear soft music minus the effect that we associate with soft music in actuality. We hear, in fact, a kind of dwarf music with all its full-sized proportion scaled down.

Now there is no question that we want to scale down music from symyphony orchestra size to fit our living rooms, but the scaling down in which we should preserve the original balance of the music is only the reduction necessary to suit the smaller room. In other words, the sound delivered to the ear in the living room should match that delivered to the ear in the concert hall. If the intensity level at the listener's ear is to be the same in both cases, it is obvious that a perfectly flat response is what is desired; but when a lower level is desired in the living room (again at the listener's ear), it should still match the lower level heard in the concert hall—which can be achieved in the concert hall by moving back to a point where the level at the listener's ear falls to that desired. Now in both cases the Fletcher-Munson curve will operate in the ear of the listener, and the effect will be the same. To forestall this effect by introducing a compensation is to produce an effect that has no counterpart in real life.

I strongly suspect that it is that old urge for excessive "boom" at work again leading engineering thought to find a justification for something that some people just happen to like. If people want "boom," by all means let them have it; but they should have it honestly by means of the bass control.

John F. Pile,
615 Hudson Street,
New York 14, N. Y.

(*We don't think we agree. See* Editor's Report, *p. 12*)



EDITOR'S REPORT

HANDBOOK OF SOUND REPRODUCTION

EVERY SO OFTEN, we are privileged to dig up one feature or another which is of outstanding merit, and we believe we have done just that this last month. Beginning with the next issue, a complete *Handbook of Sound Reproduction* will be presented, running for probably two years before the entire subject is covered. Edgar M. Villchur, who instructs a course in the high-fidelity reproduction of sound at NYU, is the author, and the several installments so far received indicate an exceptional ability to present the subject in a manner which is thoroughly understandable, and yet doesn't read like a primer. Quoting from Mr. Villchur's preface:

"In a book such as this, the choice between mathematical and descriptive analysis continually presents itself. The author is between two fires: one of mathematical treatment which makes many readers automatically turn the page, and the other of over-simplification which makes analysis incomprehensible or even inaccurate.

"The level and subject matter of this volume parallels that of a course in the reproduction of sound given by the author at the Division of General Education, New York University. Basic ideas expressed by equations are also presented descriptively, so that if the mathematical material is glossed over the sense will not be lost. For those who will follow the more involved sections in detail it may be stated that, for the most part, a knowledge of elementary algebra alone is required.

"The chapters on amplifiers assume a knowledge of the fundamental concepts of vacuum-tube circuits."

Following its publication in serial form, this material will be assembled and made available as a book, and in our opinion it is suitable for use as a text in any course in audio engineering. We welcome Mr. Villchur as a Contributing Editor, and commend his material to *every* reader—novice or professional.

LOUDNESS COMPENSATION

In the Letters column in this issue is an interesting approach to the whole subject of loudness controls—one which seems to be rather unique. While we do not agree with Mr. Pile, we think he has a right to his own opinions, and he has expressed them so well that we think everyone ought to read them.

Without doubt, no exact counterpart exists in real life to an orchestra playing at a level of 50 to 60 db with the balance between instruments that goes with a level of 80 to 90 db. But—and here's where we differ with Mr. Pile—we don't want to go through life listening to an orchestra from a back seat in the concert hall, nor from the lobby, nor from the far reaches of Grant Park. Perhaps we never do hear an orchestra in real life as we hear it with a compensated control, but it has been our experience that most listeners have found that it is far more satisfying to scale down the orchestra by means of a loudness control than it is to listen always from a distance.

In our opinion, one of the principal reasons for the upswing of interest in good home music reproduction has been the removal of most of the "highs" from "high fidelity." Early hi-fi systems always had too many highs—they were perpetually screeching at you. And we admit that we have gone through that stage too. As purists, we wouldn't have a tone control—the system had to be flat; as we know now, such a system could only sound right if it were played at the same level as the original performance of the music. The loudness control has only done what could have been done with tone controls of good design, but it is entirely automatic, and that is certainly something in its favor.

Anyway, Mr. Pile has had his say and we have had ours. Now we would welcome anyone else with a word on this more or less controversial subject.

FATHER OF RADIO

We were privileged to attend a dinner on April 8 in celebration of the fiftieth anniversary of the entry into commercial wireless telegraphy—radio, to you—of Dr. Lee de Forest, "Father of Radio," now in his seventy-ninth year. The event also commemorated the forty-fifth anniversary of the birth of the audion—the first three-element vacuum tube. This invention has been called, by Nobel prize winner Dr. I. I. Rabi, ". . . so outstanding in its consequences that it almost ranks with the greatest inventions of all time."

Truly an old-timer in this business, Dr. de Forest is by no means completely "retired." He admits to having recently filed a patent application on an improvement on, of all things, the transistor.

Former President Herbert Hoover and Mr. Charles A. Edison, former Governor of New Jersey and son of Thomas A. Edison, were the principal speakers. The De Forest Pioneers closed the event by presenting to Yale University a bronze bust of Dr. de Forest, who graduated from Yale in the Class of 1896.

CARE OF PHONOGRAPH RECORDS

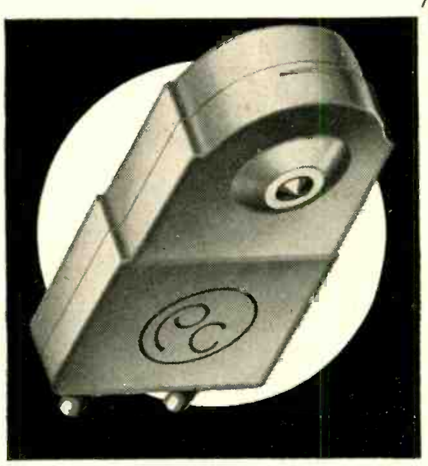
If your principal source of music is from phonograph records, you will be interested in an article on their care which is planned for next month. Written by Maximilian Weil, it sums up practically everything anyone who uses records needs to know if he is to keep his records in optimum playing condition. Look for it in the June issue—better yet, *don't miss it.*

THE 3 B'S...BEETHOVEN, BRAHMS AND BACH

they're different

they're improved

they're better than ever!



Yes, Bach, Beethoven and Brahms are now better than ever—we don't mean we've improved their music, but we *do mean* we've improved the reproduction of their *recorded* music.

It's the new, improved Pickering Cartridges that give credence to this claim. Yes, Pickering Cartridges are *different*. They're *improved*. They're *better* than ever. Pickering patented Cartridges with Dynamic Coupling* are superior in every way, by providing . . .

HIGHER FREQUENCY RESPONSE • NEGLIGIBLE INTERMODULATION DISTORTION • BETTER TRACKING CHARACTERISTICS

REMEMBER Pickering engineers and designers have but one objective . . . to produce products that will please the music lovers' insatiable appetite for the flawless recreation of recorded music . . . for the utmost in quality insist upon Pickering Audio Components. . . . Pickering diamond stylus cartridges . . . not only wear longer but, *more important*, they preserve the musical quality and prolong the life of your record library.

* *dynamic coupling assures*

- constant stylus contact with the record grooves over the entire audio spectrum (20-20,000 cps)
- full frequency response • full transient response

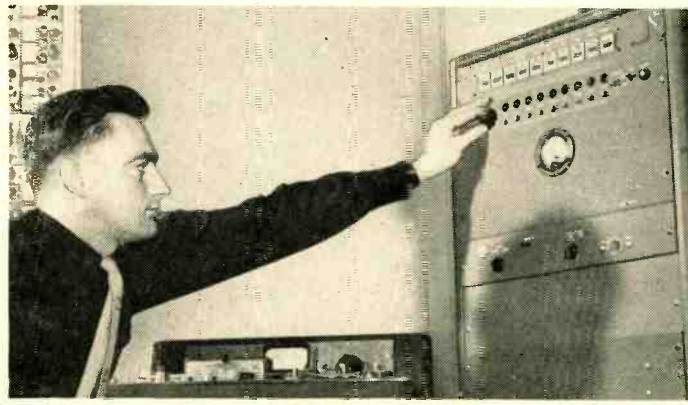
NO RESONANCES • NO MISTRACKING • NO GRINDING OF GROOVE WALLS

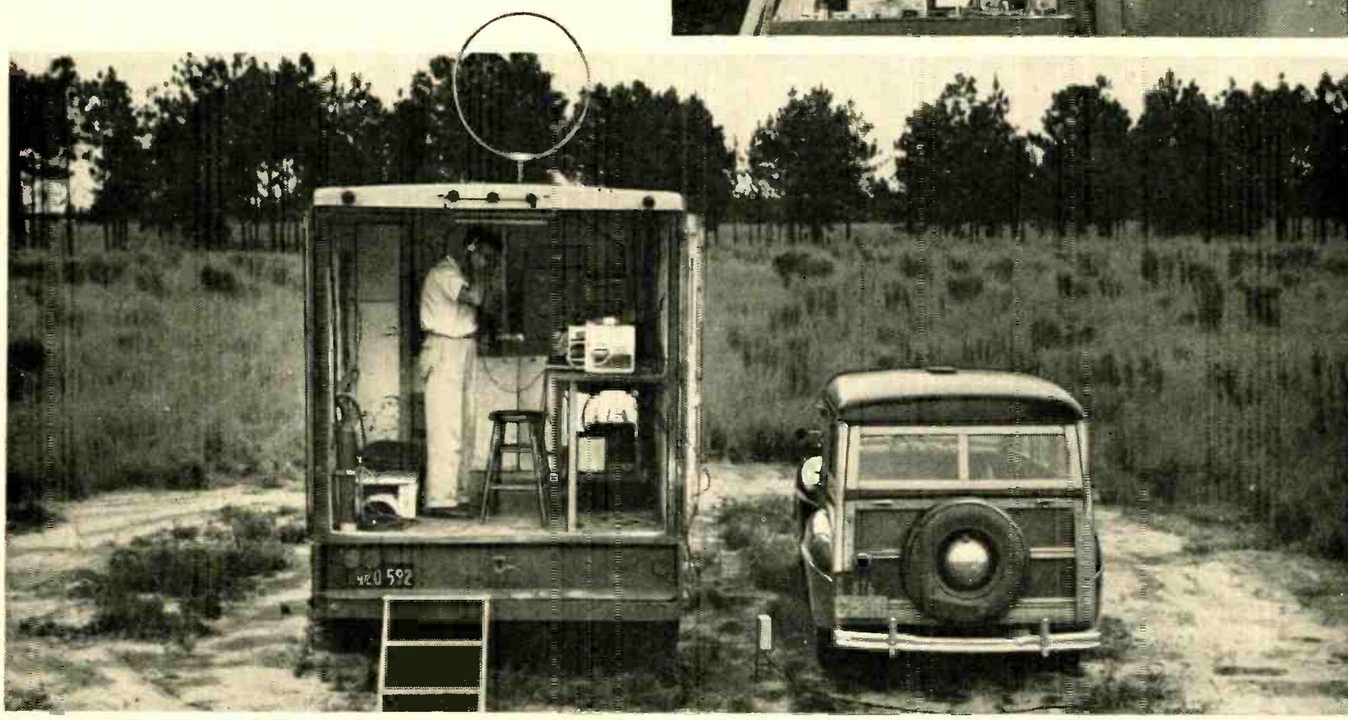
PICKERING *and company, incorporated*

● *Pickering High Fidelity Components are available through leading Radio Parts distributors everywhere; detailed literature sent upon request. Address Department A*

Oceanside, L. I., New York

Thunder Hunters





Thunder hunting equipment on location near Madison, Florida. Loop antenna on truck picks up static. The engineer in top picture is watching the indication of a circuit which registers how often the static exceeds a given level.

Many new telephone circuits have two jobs to do—carrying your voice and transmitting signals to operate dial exchanges in distant towns. And an old-fashioned thunderstorm can interfere with both!

"Rolling static" comes from many storms over a wide area and can interfere with clear telephone talk. A nearby lightning flash makes "crack static" which, unchecked, plays hob with dial system signals.

So Bell Laboratories scientists go "Thunder Hunting" in the storm centers of the United States — "capturing" storms by tape recorders. Back in the Laboratories, they recreate the storms, pitting them against their new circuits. This method is more efficient and economical than completing a system and taking it to a storm country for a tryout. It demonstrates again how Bell Telephone Laboratories help keep costs down, while they make your telephone system better each year.

BELL TELEPHONE LABORATORIES

Improving telephone service for America provides careers for creative men in scientific and technical fields.

Using Hearing Characteristics in Tape Editing*

JOEL TALL**

With the increased popularity of tape recorders, more users are beginning to do their own tape editing. The "tricks of the trade," as described by a professional tape editor, will aid in obtaining professional results.

MAGNETIC TAPE and magnetically striped and edged film are basic tools now in the production of radio and television broadcasts, commercial records and motion pictures. Within four or five years it is probable that scenes will be magnetically recorded on wide tape with the accompanying sound directly opposite on the same tape. When that happens the magnetic tape editor will have to study the psychology of the human animal more than he does now.

It is now a routine matter to obtain extremely faithful audio recordings magnetically. Noise levels approaching –60 db are commonly possible, while –70 and –80 are obtainable under laboratory conditions and with special tapes. Tape is capable of high fidelity, it is economical to use because it is erasable, and it is easily edited. This advertised ease of editing has paradoxically resulted in a greater appreciation of good editing by those whose business it is to know the difference between good and indifferent editing—the producers of top-grade radio and TV production. Tape-editing has grown up. It is an art, it is complex, and it requires much more than just mechanical adeptness. A good tape editor should be capable of discerning slight differences in acoustic response. He must be a dramatist. He should recognize moods, audio color, listeners' mental reactions to stimuli. He would be a better editor if he studied phonetics, music, and psychology. And he must know hearing—for the fluidity and naturalness of the work he produces depends upon how well he knows what he hears. That is not as simple as it appears on the surface.

"Naturalness" can have two meanings. The first is this: that an edited tape should sound as though it belonged—it should be an integral part of the idea it is meant to express and it should contain nothing to indicate that it has been edited. The second meaning is: even though a sound is "unnatural," it should be edited to approximate nature. In other words, if we use a sound effect to create a mental impression in the listener's mind, the effect should be presented in a natural manner so that the listener is not suddenly made to realize that the sound is artificial.

The methods of cutting tape are now well established—you may use scissors or an editing block or an automatic splicing machine. To produce well-edited audio of any kind, however, requires of the editor—and the producer—both a realization of all the factors that make for good listening and some knowledge of the psychology of hearing in addition to adeptness with scissors or razor blade.

Effect of Human Hearing

Our hearing abilities, though they may be normal, are governed by the condition of the mind and the nervous system. Oftentimes we accept a suggested sound as a real one. Our recovery of hearing ability after a shock of high level sound is fairly gradual—from a twentieth to a tenth of a second and sometimes even more. The persistence of the sensation of hearing after the exciting sound has passed can be utilized in editing, and the fact must be recognized that we cannot trust our ears when we are fatigued. All these facts can be incorporated in a method for editing. The method consists largely in knowing exactly how various sounds affect the hearing. The limitations of hearing are its basis—the application of this knowledge results in editing that cannot be perceived, as a change of any kind, by the listener. And, in the last analysis, it is the listener who must be pleased. In order to please that ubiquitous person—the listener for whom the polls are held—the tape editor must give heed to the structure of the program—its mood, pace, level, and inflections, the background sound, variations in the recording fidelity, and the plot, if any.

The mood of a program depends upon plot, upon the little thread of an idea that ties the show together and integrates it. It is normally the job of the producer of the program to decide how the different parts of the puzzle can fit together acoustically. From mood stems the pace which must be maintained, and changed as called for, in editing. Changes of pace should fit into changes of mood or plot—they should make sense. It will be immediately obvious if they do not. Sudden changes in level at the wrong places are undesirable, and we cannot end a thought on an *up* inflection. These are all routine matters to any tape editor. One standard caution is that against making a sudden transition from one background to another. Except where specially noted, backgrounds should be the same. If they are not the same, the transition from one to the other should be gradual—either so gradual as to pass unnoticed or else edited to suggest a change of *place*, as will be described shortly. In listening to a show we do not hear the background noise particularly unless it is suddenly missing; then we are most aware of its absence.

The limitations of human hearing may be utilized in many ways in editing tape. The same techniques may be used in editing sound no matter what the recording medium may be.

Recognition of sound depends upon the audio apparatus by means of which the tape editor hears the sound and upon his own hearing system. The whole playback system—and that term includes the room in which the editor does his work—should reproduce the audio as faithfully as possible. If the editor is to produce a finished, natural-sounding show, his hearing must not be burdened or strained by poor amplifiers, speakers, or room acoustics. The best available is none too good for the editor's use.

Ear Sensitivity

Most of us do not appreciate how sensitive the human ear is. At its point of greatest sensitivity (about 3000 cps) it can almost detect the noises due to the collisions of air particles in space—the Brownian movements, so called. That is, of course, when no other sound is present. Fortunately, we do not exist in perfect silence. It is said to be a most frightening experience. The ear, then, is very sensitive, but it is selectively sensitive in frequency, and is most sensitive normally about 3000 cps, as was pointed out by Harvey Fletcher and corroborated by many other noted experimenters.

It is a peculiar fact of human psychology that we do best the things we

*A preprint from "Techniques of Magnetic Recording" to be published soon by The Macmillan Company.

** *1594 Unionport Road, Bronx, N. Y.*

make no conscious effort to perform. We see best if we do not strain to see, we think best when we do not strain the contents of our craniums, and we hear best when we do not try too hard to hear. Our hearing system can be easily fatigued during a long editing session. When is is subject to fatigue it is worse than useless; it can cause errors of judgement and mistakes in editing that, in retrospect, should have been impossible to make! The monitor system for editing should *not* be a flat system. A system with the center frequencies—say from 800 to 3500 cps—depressed a few db is more comfortable to listen to, without straining, for long periods of time. If the editor can hear the whole audio range, clearly, without straining, at room volume, he can do his best work for the longest period of time without aural fatigue. This dictum stems from the following reasoning:

Experimenters have noticed that when the intensity of sound is increased almost to the point of pain, the ear hears low-frequency sounds pitched lower and high-frequency sounds pitched higher. The ear, in its desire to avoid discomfort due to over-loading at its most sensitive mid-frequency range, shifts the recognition of sound—which is pitch—away from the vulnerable "hurting" point. We know that recognition of pitch is absolutely necessary to professional editing. Therefore, if overloading at mid-range is likely to induce a shift in pitch perception, why not depress the mid-range sufficiently to avoid the onset of this pitch shifting fatigue factor? This has been done experimentally and editing is better. Also, it is possible under these conditions to edit almost twice as long before hearing fatigue sets in. Note that speaker output should be good from 50 to at least 10,000 cps. For many reasons the editor finds most of his information for cutting in the very low and very high frequencies. The mid-frequencies can be attenuated considerably without incurring any errors in editing.

Fatigue

It may be that some readers have not experienced hearing fatigue. Hearing is a personal sense and may differ considerably with different personalities, so the writer will describe his own reactions. Hearing fatigue causes a tightening of the physical components in the hearing system, which results in a shifting of the perception of pitch as mentioned before. Lows, although heard, sound strangely flat and distorted, highs are piercingly shrill, wolf-tones in mid-range cause discomfort, and the ears sometimes refuse to hear a short sound. Which of these effects are due to the ear mechanism, the nervous system, or the brain the writer does not presume to be qualified to say. But the fact remains that auditory fatigue incapacitates a good tape editor. In that state he is incapable of exerting his skill or his judgment—sound to him then is a meaningless jumble. When your hearing exhibits any of these symptoms, or a general cloudiness of reaction like that experienced when slightly drunk, stop editing. At least do not attempt then to create an artistic piece of work.

The study of auditory fatigue is worth your while if you intend to devote some time to editing, because it delineates the extremes of the normal limitations of hearing. Some of the errors of perceptions present to a great extent during auditory fatigue are present to a *lesser* degree during normal relaxed audition. The editor who knows how to do so can take advantage of these idiosyncracies both to lighten his labors and to perform more artistically.

One of the idiosyncracies of hearing has to do with the rapidity with which the ear can recognize a sound as a sound with a definite pitch. To paraphrase Will Rogers' famous saying, "All we know is what we hear from the speakers." Some years ago, when the first tape editing block was designed by the writer, the cutting slot was arranged on a diagonal. A sales engineer for one of the tape manufacturers saw him using it and inquired the reason for the diagonal cut. It was explained that this cut produced the least noise at the splice from too abrupt beginnings and ending of sounds.

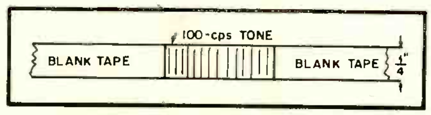


Fig. 1. When a 100-cps tone, for example, is cut at a 90-deg. angle, a click is heard at the beginning and end of the tone. This noise seems to decrease with increasing frequency of tone—probably due to more efficient masking at higher frequencies.

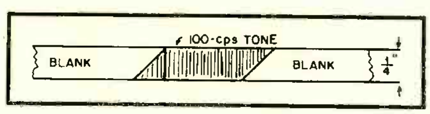


Fig. 2. When the 100-cps tone is cut at a 45-deg. angle, no click is heard.

The diagonal cut has since been adopted by everyone using tape (with the exception of editing non-audio markings) because it reduces the possibility of causing transient sounds to be heard. There is a fairly definite limit *in time* to our perception of discrete sounds. There is also a definite limit in the slope of the wave front of sound—what is heard as sound with a musical pitch and what is heard as noise. We could all agree that there is such a thing as a natural sound—a sound that *can* be originated and propagated in a natural medium—and an unnatural sound which could not exist in nature. Sounds, in nature, rise and fall more or less gradually. Artificially steep wave fronts do not seem to exist.

Naturalness of Sound

For as long as humans have existed, we probably heard natural sounds. Since our sense of hearing is intimately connected with the brain and our thinking is controlled by memory—whether recent, old, or inherited—we cannot conceive of a sound that is not natural. (Have you never been frightened by a strange sound?) When we "hear" a sound that is too short for mental recognition, or too short for our nervous system to react to, we hear noise. Our hearing cannot, or will not, receive as sound with definite pitch the sharp wave-front caused by the sudden onset of an oscillator tone, for instance. When tone is keyed on or off we hear clicks. You have all experienced that. If we record a steady 100-cps tone, and then cut it at a 90-deg. angle and insert quiet tape before and after it, we hear "clicks" or noises when the tone begins and when it ends (see *Fig.* 1). The "clicks" are not on the tape, they are in the hearing, and they are there because of the time factor of pitch perception. Therefore, do not cut any sound abruptly, but cut it at an angle, as in *Fig.* 2. This applies especially to background sounds, but any sound should be edited so that it *sounds* natural—gradually rising and gradually dying out. (This is true even of pistol shots. If a pistol shot is simulated so that there are unnatural transients at the beginning and end, it will not ring true and will have distorting noise at its start and finish.)

It is very difficult, in comparing the theory of hearing with experience, to come to a definite decision as to the length of time necessary for recognition of sound. Stevens & Davis, in "Hearing," published by John Wiley & Sons, mention that recognition of pitch at the mid-frequencies can be effected in one hundredth of a second, with the time increasing both at low and high frequencies. Of course, recognition of complex sounds will vary according to what is the dominant band of frequencies, what its level is, how much it is masked, and so on. From the standpoint of a practical editor, absolute rules are not needed; as long as he knows the causes and effects and can apply the needed cure.

Persistence

The persistence of the sensation of hearing is analagous in some respects to the persistence of vision, but it is nowhere near as long in duration. If there were any marked degree of persistence in hearing, it would have to be due, partially at least, to less than critical damping of the hearing mechanism itself. Common-sense, as well as theory, tells us that the ear is an extraordinarily well-damped piece of apparatus. How else could it analyze complex waves, as it does, if this were not so?

Many investigators, as far back as Helmholtz, have tried to measure the persistence of the sensation of hearing. It has been reported, by Drs. Stevens and Davis (*loc. cit.*) that a tonal sensation takes almost 0.14 seconds to die out after stimulation stops. The writer cannot dispute this conclusion experimentally, but the work he has done in editing leads him to believe that, for

[*Continued on page 50*]

Universal Amplifier for Magnetic Tape Recorder

C. G. McPROUD

Part 1. The description of an amplifier which combines the ability to serve in professional applications as well as to work with a conventional home music system, and in addition, it doubles as a broadcast remote amplifier.

About fifteen years ago, the writer acquired an urge to have a broadcast remote amplifier — for some reason which still remains obscure—and a number of futile starts were made to fulfill that desire. An extremely small unit which would be quite flexible was contemplated — but was never built in that form.

Following the purchase of a professional tape recorder a few months ago, the need for a record-and-playback amplifier again resurrected the urge for a small flexible unit, and the design to be described was the result. Before launching into a description of the amplifier, its various functions will be discussed.

Primarily, the unit was to serve as the record and playback amplifier to work with a home music system of conventional design. Thus it required two channels, one for recording and one for play-back, and both able to work simultaneously so that the recording could be monitored from the tape. It was therefore necessary to have a high-impedance input for the record amplifier, and an output which could be arranged to feed a high-impedance circuit following the playback preamplifier and equalizer.

It was also desired to be able to mix a microphone with the signal from a radio or phonograph. This function has some drawbacks, but it seems to work satisfactorily in practice.

Fig. 1. Compact, yet with a mulfitude of capabilities, this unit works with a standard tape recorder to turn out professional work.

For occasions where it might be necessary to record from two microphones at the same time, two low-impedance inputs were considered necessary. Thus the amplifier could be used to mix any two signal sources at mike level.

By suitable connections, the record feature was to be eliminated so that the amplifier could serve as a broadcast remote unit, mixing two microphones, and feeding a balanced line through a 6-db H pad, ungrounded.

As the circuit developed, it was found that the two-channel feature could be used in a small studio, if desired, as a program amplifier and an audition amplifier at the same time, or as a program or audition amplifier and a talk-back amplifier, also at the same time.

And it was also found, as the circuit began to take shape, that it could be used as a reverberation generator, employing the delay of the tape machine—due to the spacing between the record and playback heads—to provide the time delay necessary for reverberation.

One more feature was worked into the circuit—that of being able to plug in three microphones and switching so that any two of the three could be used simultaneously, or, if recording and monitoring at the same time, two microphones could be plugged in, and either one could be selected at will by means of a switch.

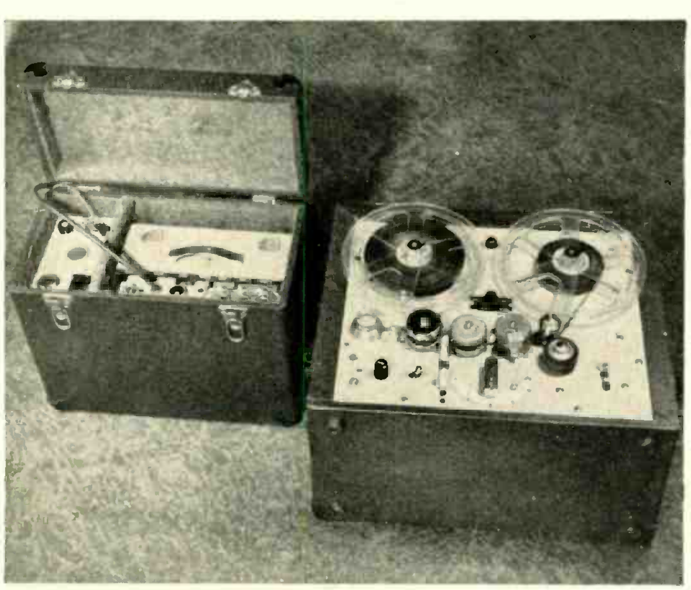


Fig. 2. The amplifier in its carrying case with the portable power supply, and the recorder for which it was designed.

A number of other features were incorporated—mainly to increase flexibility. Among them were switching for the VU meter, making it possible to feed the recorder or the line at three levels as well as to measure bias and erase currents, and to permit the meter to be used for other purposes by employing a plug wired in a certain manner. The output key was arranged so

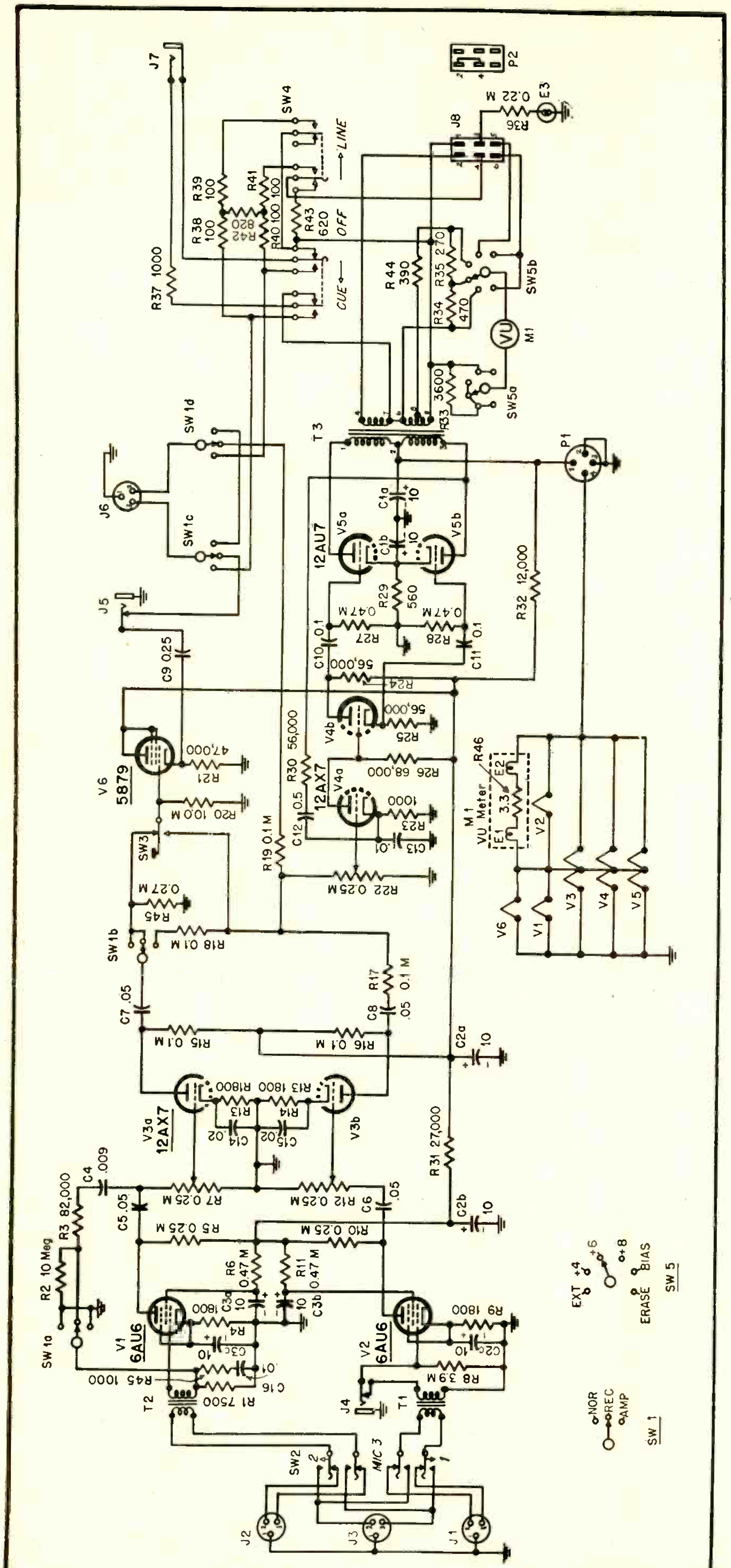


Fig. 3. Complete schematic of the amplifier chassis. Equalization for recording is furnished by a passive equalizer mounted in the recorder case. For use with this amplifier, the playback head must be shunted with a 33-ohm resistor.

PARTS LIST

C_1	10-10/450, electrolytic
C_2, C_3	10-10/450, 10/25, electrolytic
C_4	.009 µf, mica
C_5, C_6, C_7, C_8	.05 µf, paper, 600 v.
C_9	0.25 µf, bathtub, 400 v.
C_{10}, C_{11}	0.1 µf, 600 v.
C_{12}	0.5 µf, upright can, 600 v.
C_{13}, C_{16}	.01 µf, paper, 400 v.
C_{14}, C_{15}	.02 µf, paper, 400 v.
E_1, E_2	Dial light, #291, 0.17 a, 2.9 v.
E_3	NE-51 Neon glow lamp
J_1, J_2, J_3	Cannon XL-3-13 receptacle
J_4, J_5	Switchcraft 12A jack
J_6	Amphenol 91-PC3F receptacle
J_7	Switchcraft 11 jack
J_8	Jones P-306-AB plug
M_1	−20—0—+3 VU meter, G. E.
P_1	Amphenol 91-MC3M, on 6-ft. 3-wire cable
P_2	Jones S-306-FHT, shorted between terminals 2 and 4
R_1	7500, ½ watt
R_2, R_{20}	10.0 meg, ½ watt
R_3	82,000, ½ watt
R_4, R_9, R_{13}, R_{14}	1800, ½ watt
R_5, R_{10}	0.25 meg, IRC Type DCF
R_6, R_{11}	0.47 meg, 1 watt
R_7, R_{12}, R_{22}	0.25 meg pot, Ohmite CA 2541
R_8	3.9 meg, ½ watt
R_{15}, R_{16}	0.1 meg, 1 watt
R_{17}, R_{18}, R_{19}	0.1 meg, ½ watt
R_{21}	47,000, 1 watt
R_{23}, R_{37}, R_{45}	1000, ½ watt
R_{24}, R_{25}	56,000, 1 watt, 5%
R_{26}	68,000, 1 watt
R_{27}, R_{28}	0.47 meg, ½ watt
R_{29}	560, ½ watt
R_{30}	56,000, ½ watt
R_{31}	27,000, 1 watt
R_{32}	12,000, 1 watt
R_{33}	3600, 1 watt, 5%
R_{34}	470, ½ watt
R_{35}	270, ½ watt
R_{36}	0.22 meg, ½ watt
R_{38}, R_{39}, R_{40}, R_{41}	100, ½ watt
R_{42}	820, ½ watt
R_{43}	620, ½ watt, 5%
R_{44}	390, ½ watt
R_{46}	3.3 ohms, ½ watt
$Sw_{1a, b, c, d}$	Mallory 3143J switch
Sw_2, Sw_4	Stromberg Carlson 172-A key
Sw_3	Switchcraft 203 push button
Sw_5	Mallory 3126J switch
T_1, T_2	Input transformer, 30 : 150,000 ohms; Western Electric D-95495
T_3	Output transformer, pp plates to line, 20,000 : 600 ohms; ADC 315B
V_1, V_2	6AU6
V_3, V_4	12AX7
V_5	12AU7
V_6	5879

TRANSFORMER SUBSTITUTIONS*

Make	T_1	T_2
Chicago	BI-2	BO-2
Peerless	K-221-Q	S-220-Q
Stancor	WF-21	WF-36
Triad	HS-5	HS-52
UTC	A-11	HA-114

* While these transformers meet the electrical requirements, they are not necessarily of the same physical dimensions, and may not substitute directly in the same sized chassis. They should, however, perform satisfactorily in the circuit.

as to terminate the amplifier, when used as a remote unit, and connect the monitoring headphones to its output for rehearsal and level setting; or to connect the phones across the line to receive cue from the station on a remote job; or to connect the amplifier to the line through the 6-db pad with the headphones monitoring the output. Another switch was connected so as to permit monitoring of the radio program to be recorded — when using the amplifier with a home system—direct from the input, rather than from the tape.

Circuit Description

The completed amplifier, shown in *Fig.* 1, was built in a case which is exactly like several audio test equipment units used by the writer, and which happened to be available. It is a trifle too small for ease in construction—measuring 8½ in. wide, 8 in. deep, and 5½ in. high. However, after it was completed, its small size was an advantage. The power supply is separate, and the equalizer for the recording head is placed within the recorder case—where there is considerably more room. Two power supplies are used, actually—one is permanently mounted in the home equipment, and the other is installed in a carrying case semi-permanently, along with space for the amplifier itself, as shown in *Fig.* 2 with the recorder. For the information of anyone who may be interested enough to inquire, the lettering on the panel was done quite easily with *Tekni-Cals,* a variety of decalcomania designed for radio purposes.

The schematic, *Fig.* 3, shows two preamplifier stages, two gain controls, and the two separate voltage amplifiers, the mixing network and the master volume control, and the output amplifier—a push-pull 12AU7. In addition, a cathode follower, V_6, is used to feed the second channel back to the radio amplifier, or for the audition or talk-back application.

For ease in understanding the operation of the circuit in the three positions of the SELECTOR switch, the block diagrams of *Fig.* 4 should be studied. In normal operation of this amplifier with a home system, a high-impedance circuit —preferably between the control amplifier and the main amplifier—is opened, and the output of the control amplifier and the input of the power amplifier are brought to the recording amplifier by means of a two-conductor plug which is inserted into J_6 in this unit. If the recording amplifier is to be removed from the circuit, the plug is simply shorted by inserting it into a receptacle which has its terminals wired together.

When connected to the recording amplifier, however, it is necessary to short this pair of leads while the recorder is not being used. Thus the SELECTOR switch has one position labeled NOR—for normal—which shorts the radio line, and the power supply may be turned off, putting the entire equipment effectively out of the circuit. At the same time, the amplifier is set up in a two-channel configuration. The main channel, consisting of V_2, V_{3b}, V_4, and V_5, is connected straight through, and may be used as desired, making the output connections to terminals of J_8.

The second channel consists of V_1, V_{3a}, and V_6, and feeds out from a cathode follower to any suitable high-impedance load. Both channels are "flat," and gain is adequate for low-level microphones. J_2, in the main channel, will accept a high-impedance microphone or some other source which may be operated unbalanced. An unbalanced signal of around zero level may be fed in at J_6 and mixed with the mike if desired.

When using the amplifier for audition and program at the same time, the second channel is simply connected to a monitoring amplifier with a high-impedance input, and any signal introduced into T_2 will be available at the output of V_6, at J_5.

System Philosophy

There are two basic types of equalization which are necessary in any magnetic recording system—that caused by the finite width of the gap, and that due to the magnetization characteristic of the tape itself. The former must compensate for the loss in high frequencies as the wavelength of the recorded signal approaches the width of the gap, and is of the order of 20 to 25 db at the frequency where the wavelength is equal to the gap. The latter requires a boost at the rate of 6 db per octave as the frequency is lowered, with a turnover somewhere in the vicinity of 3000 cps.

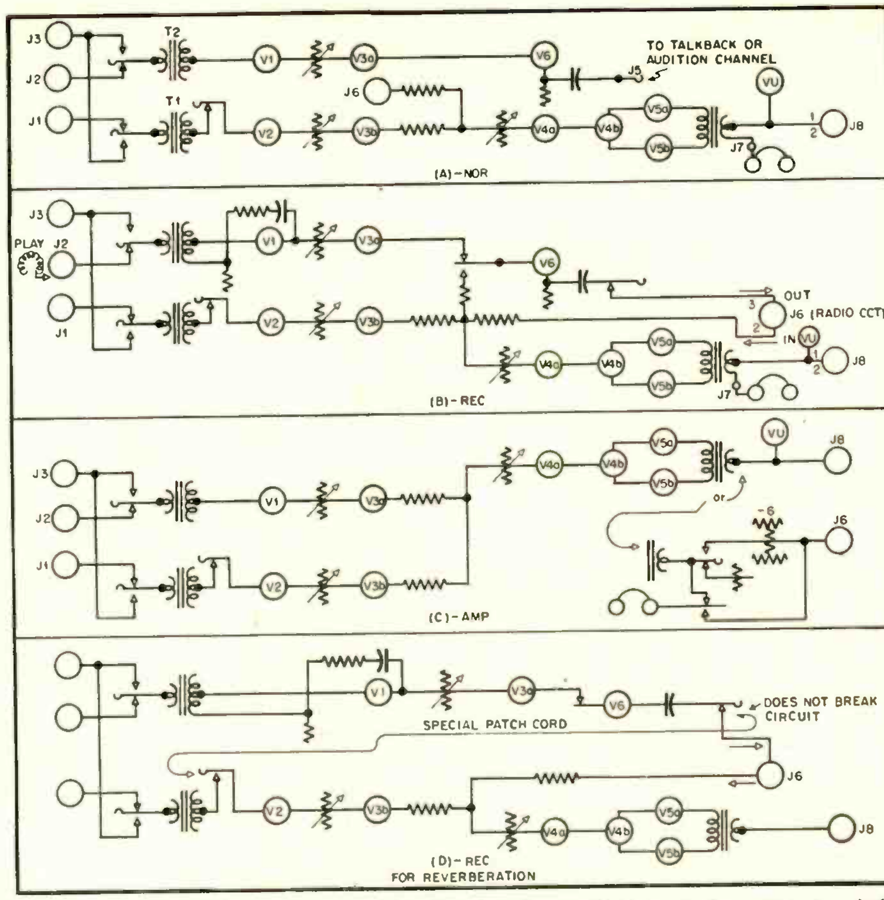


Fig. 4. Block schematic of the amplifier for the three positions of the selector switch, $SW_{1a, b, c, d}$, and when connected for reverberation. When connected to a home music system, J_6 is shorted so the unit is out of the circuit when the selector switch is at NOR.

In most professional machines, the high-frequency equalization is introduced in the recording circuit, principally because a boost in playback would decrease the signal-to-noise ratio. And in order to avoid overload of the tape, the low-frequency equalization is introduced in the playback amplifier, in much the same manner as with magnetic pickups. Many of the non-professional machines employ the same amplifier circuit for both recording and playback, introducing half of the required equalization in each operation. This simplifies the amplifier design, but runs the risk of overloading the tape on lows; and it reduces the signal to noise ratio by boosting the highs in playback.

Since this machine was to be used for professional applications, the first method of equalization is employed. The high-frequency equalization is provided by a passive network between the output of the amplifier and the recording head (not shown in the diagram, but located inside the recorder case), and the low-frequency boost is obtained by working the 500-ohm head into a 30-ohm transformer primary which is shunted by a 33-ohm resistor. This furnishes most of the low-end boost, the final adjustment being provided by a feedback network around the first stage when the circuit is switched to REC, which is the correct position for playback.

Further discussion of the circuit and a description of the construction will follow in the June issue.

(To be continued)

It's Positive Feedback

WARNER CLEMENTS*

The use of Positive Feedback to nullify the effect of voice-coil impedance was first presented in these pages by the author, who takes issue with a succeeding article on the same subject. He states his case clearly.

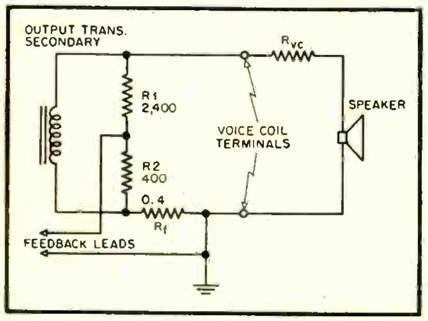


Fig. A. Convenient means for applying positive current feedback along with negative voltage feedback. (Fig. 2 from Childs' article.)

In the August 1951 issue of Æ there appeared an article by this writer describing his circuit for obtaining vastly improved loudspeaker damping. More recently, the February 1952 issue carried an article by Ulric J. Childs discussing the circuit further. While Childs agreed on the general merits of the circuit, at several points his findings were at variance with those of the writer. Some divergence was to be expected. By comparison with more conventional feedback arrangements which have been in almost universal use for many years, this one is virtually unproved and untested. Unfortunately the issues which Childs raised are vital and fundamental ones. It is the purpose of the present article to try to reconcile the conflicting findings to everybody's satisfaction; and in so doing to cast additional light on the principles that govern the operation of the circuit. It will not be necessary to study the mathematics presented in order to follow the thread of the argument.

Figure 2 of Childs' article is here reproduced as *Fig.* A. The reader can confirm that it is identical with *Fig. 7* of the writer's original article, except that the optional feedback inductance is not shown. First, let's consider the matter of the role of positive feedback. If R_f in *Fig.* A is made equal to zero, the circuit becomes an ordinary negative feedback circuit. R_f, then, is what makes the difference between an entirely conventional arrangement and the high damping circuit under discussion. As R_f is increased from zero, the gain, distortion, and instability all increase. It has been conventional for many years to call feedback that increases the gain "positive" feedback.

The writer's original article recommended using enough negative feedback to more than cancel out the increased distortion due to the positive feedback. In a sense, then, the article was calling for more negative than positive feedback and would seem to have been clear enough on this point. But to say that "net" feedback is always negative under these circumstances is not quite correct, as will be shown.

The clincher is that negative feedback

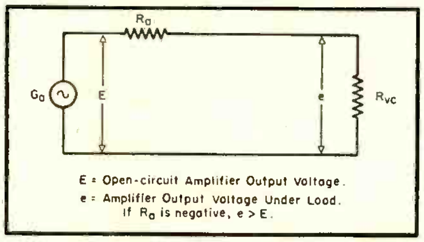


Fig. C. Equivalent circuit used by Childs to establish point of oscillation. (Fig. 3 from Childs' article.)

is not really necessary at all for the operation of the generalized circuit. *Figure* B shows circuit and formulas applicable to a non-feedback amplifier. (Of course, if the amplifier were enclosed in a "little black box" no one would know from the outside whether or not some inverse feedback had been sneaked in; the formulas would still be applicable using measured gain and output resistance.)

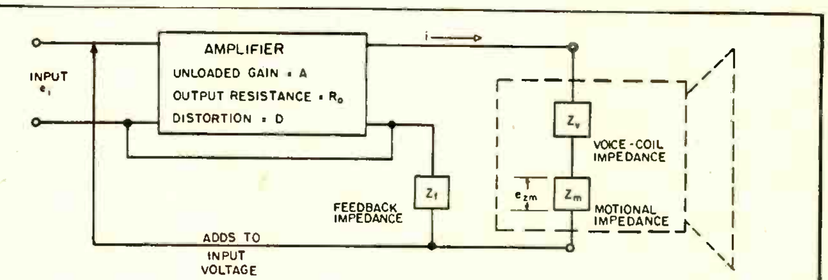
Perhaps the most important point at issue is the possibility or impossibility of perfect loudspeaker damping. The question is a fascinating one from a theoretical standpoint. But more than that, it is of immediate practical importance to the designer or constructor who wants to know if, in increasing R_f, he can possibly go *beyond* the setting representing best damping.

"Perfect" Damping

Let it be understood that here and throughout the article when we speak of "perfect" damping we mean "theoretically perfect." In actuality damping cannot be 100 per cent perfect for the reason that there is no such physically realizable thing as a lumped circuit constant.

Childs bases his proof that perfect damping is impossible on his *Fig.* 3 circuit which is here given as *Fig.* C. He considers the voltage ratios in the circuit and states that under the condition that R_a equals the minus of R_{vc} the cir-

[*Continued on page 57*]



DIAPHRAGM VELOCITY IS PROPORTIONAL TO: $e_{zm} = IZ_m = \dfrac{Ae_i Z_m}{Z_m + Z_v + R_o - Z_f(A-1)}$ (1)

FOR PERFECT DAMPING MAKE: $Z_f = \dfrac{R_o + Z_v}{A-1}$ (2)

AT VALUE OF Z_f GIVEN BY (2), $e_{zm} = Ae_i$ (3)

OUTPUT IMPEDANCE LOOKING TOWARD AMPLIFIER FROM SPEAKER TERMINALS: $R_o' = R_o - Z_f(A-1)$ (4)

AT VALUE OF Z_f GIVEN BY (2), $R_o' = -Z_v$ (5)

DISTORTION OR GAIN-INSTABILITY: $D' = D\dfrac{R_o + Z_m + Z_v + Z_f}{Z_m + Z_v + R_o - Z_f(A-1)}$ (6)

AT VALUE OF Z_f GIVEN BY (2), $D' = D\dfrac{R_o + Z_m + Z_v + Z_f}{Z_m}$ (7)

Fig. B. Arrangement showing negative feedback is not essential to speaker damping.

* *P. O. Box 969, Sherman Oaks, Calif.*

Further Discussion on

Positive Current Feedback

ULRIC J. CHILDS*

Presenting his side of the case, Mr. Childs offers proof—in the form of measurements—of his previous position on Dynamic Negative Feedback, with a gradual approach to the original premises of Mr. Clements.

LOUDSPEAKER DAMPING is an important subject to the audio engineer and to the discriminating listener alike, whatever the method used to achieve it. In view of that, this writer is greatly indebted both to Æ for publishing and to Warner Clements for initiating the interchange of views and conclusions between the two authors presently involved, with articles by both in this issue.

Considerable thought and experimental investigation have gone on in the writer's laboratory between his last article and this one, with results that tend to agree in principle with those of Mr. Clements but differ in some important details.

To begin at the beginning, it must be acknowledged that the motional impedance Z_m of a loudspeaker cannot be neglected and Clements' Eq. (1) in this issue appears to be quite correct. Calculations are of little value, however, unless the correct quantities are inserted. There is some doubt that 8 to 10 ohms is a "typical" figure for motional impedance throughout the audio range. If it were, many amplifiers would undoubtedly be able to approach and even achieve so-called "perfect" damping, for which R_a is equal to R_{vc} and the only impedance absorbing power from the generator is the motional impedance of the speaker. Both the writer's investigation and the literature, however, appear to indicate that Z_m reaches a very low value—considerably lower than R_{vc}—at one point at least in the lower middle range. Obviously, if Z_m is very low at a frequency transmitted by the system without much attenuation, the value of e in Clements' Eq. (2) rises and amplifier instability is greatly increased (along with the negative regulation) at this frequency.

Approximately this same thought is expressed by Clements when he says that the Childs amplifier oscillated at negative-resistance values approaching R_{vc} because it is "too good." This statement was that Z_m becomes nearly zero at "frequency extremes," at which time only R_{vc} remains, and if it is cancelled out or exceeded by R_a the negative regulation tends to become infinite and incidental reactances cause oscillation.

It has consistently been the writer's experience that oscillation takes place in the vicinity of 200 cps, not at the extremes of the range. This led to investigation of the actual point at which Z_m becomes lowest, and both measurement and the literature state clearly that this point is in the lower middle range. Hugh S. Knowles,[1] for example, gives a graph showing normal input impedances vs. frequency for various speakers. The curve for the moving-coil speaker in an infinite baffle shows lowest impedance (consisting of $R_{vc}+Z_m$) within the audio range between 200 and 500 cps. As frequency rises, impedance rises, as is confirmed by Preisman,[2] who states "The output stage and voice coil in series with it exhibit essentially an inductive and resistive impedance at the higher audio frequencies. The inductance is the leakage inductance of the output transformer, plus that of the voice coil, and the resistance is the apparent source impedance . . . as viewed from the secondary terminals of the output transformer, plus that of the voice coil." We may for this discussion neglect the output transformer, the output stage, and R_{vc}; we are still left with the voice-coil inductance.

Oscillation Point

The handbook curve shows a peak of speaker input impedance at the resonant frequency, followed by a drop below that point; but as far down as 30 cps, the impedance is still somewhat higher than in the middle range cited. Apparently, much further below the resonant point, the available power amplifier and the incidental reactances neces-

[*Continued on page 48*]

[1] *"Radio Engineering Handbook,"* ed. by Keith Henney. New York: McGraw-Hill, 4th Ed., p. 753.

[2] Albert Priesman, "Loudspeaker damping." AUDIO ENGINEERING, April 1951, p. 41.

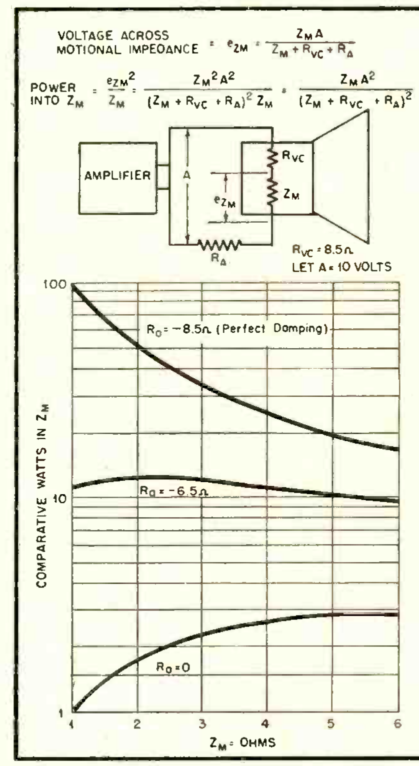


Fig. 2. Calculated curves representing power delivered to Z_m over a range from 1 to 6 ohms, for three values of amplifier resistance R_a.

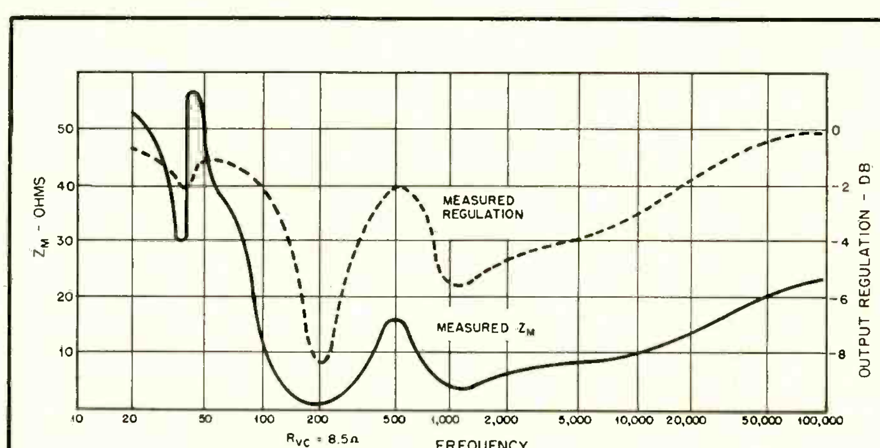


Fig. 1. Actual measured curves showing the motional impedance Z_m for a typical speaker system (solid line) and the regulation of the driving amplifier (dotted line).

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

Neutralizing Hum and Regeneration

ARTHUR L. HAMMOND*

Describing a unique method for employing the noises and hum arising from a power supply to cancel themselves out by applying them to a following stage in the correct phase and amplitude.

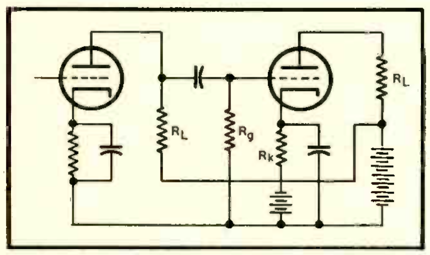


Fig. 1. Conventional R-C coupled circuit in which voltage divider action occurs between stages.

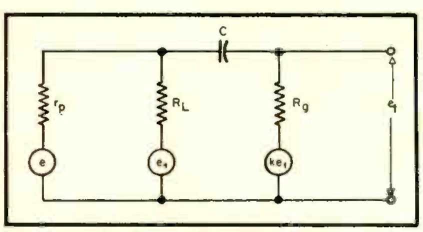


Fig. 2. Equivalent circuit of amplifier shown in Fig. 1.

VOLTAGE DIVIDER ACTION of typical amplifier coupling circuits often produces a hum or noise voltage across the input of the succeeding amplifier tube. Referring to *Fig.* 1, the noise voltage may include low-frequency oscillations (motor boating) due to unwanted feedback from the following amplifier stages, or it may include various extraneous noises arising from the power supply. The feedback action results from impedance in the power supply. Resistance-capacitance decoupling units are usually employed to correct this feedback action, but the effectiveness of such units is reduced at very low frequencies and several components are usually required.

Several balancing schemes have been proposed for reducing these hum and noise voltages, but these methods usually necessitate the difficult adjustment of several R-C components. Often the capacitances in such balancing schemes are large and costly, and the balance may vary appreciably with age due to change in value of the capacitors or the resistors comprising the balance network.

The circuits to be described are stable and are not likely to lose their adjustment with time if high-quality resistance components are used. These circuits do not require capacitance components for balance, and may be made to eliminate regeneration at all frequencies. The amplifier performance is not affected by these circuits, which also permit adjustment for the reduction of hum and foreign noises arising from the filament supply.

In an R-C coupled circuit, a portion of any hum or extraneous voltages arising across the power supply output is impressed across the grid of the following vacuum tube, due to the voltage divider action of the impedances involved. In a conventional R-C coupled circuit, such as shown in *Fig.* 1, if the impedance of the coupling capacitance is is neglected, this voltage component e_t is as follows:

$$e_t = \frac{e_1 r_p R_g / (r_p + R_g)}{r_p + R_g + R_L}$$

$$= \frac{e_1\, r_p\, R_g}{(r_p + R_g)\,(r_p + R_g + R_L)}$$

where r_p is the plate resistance of the preceding tube, R_L is the load resistance for the preceding tube, and R_g is the grid return resistor for the succeeding tube. For pentode tubes this component voltage e_t may be large. The above relation assumes perfect filtering of the screen supply, because otherwise the screen will complicate the relation by acting as a control grid for the component present in the high voltage supply.

Figure 3 illustrates a circuit employing a transformer and *Fig.* 5 illustrates a circuit employing a vacuum tube to secure approximately 180-deg. phase shift necessary for reducing the noises or feedback voltages introduced by the input coupling networks. It is desirable to employ negative feedback in the amplifier to ensure constant phase shift over the desired frequency range and to maintain constant output regardless of changes in the tube characteristics. In an analysis of the circuit using an audio transformer, the power-supply source may be considered as a constant-voltage source due to its relatively low impedance, and therefore voltage amplification by transformer action is possible. An analysis for the transformer method of securing the desired 180-deg. phase shift and voltage amplification will be given later.

Analysis

By the superposition theorem, the current flowing at any point in a linear net-

[*Continued on page 53*]

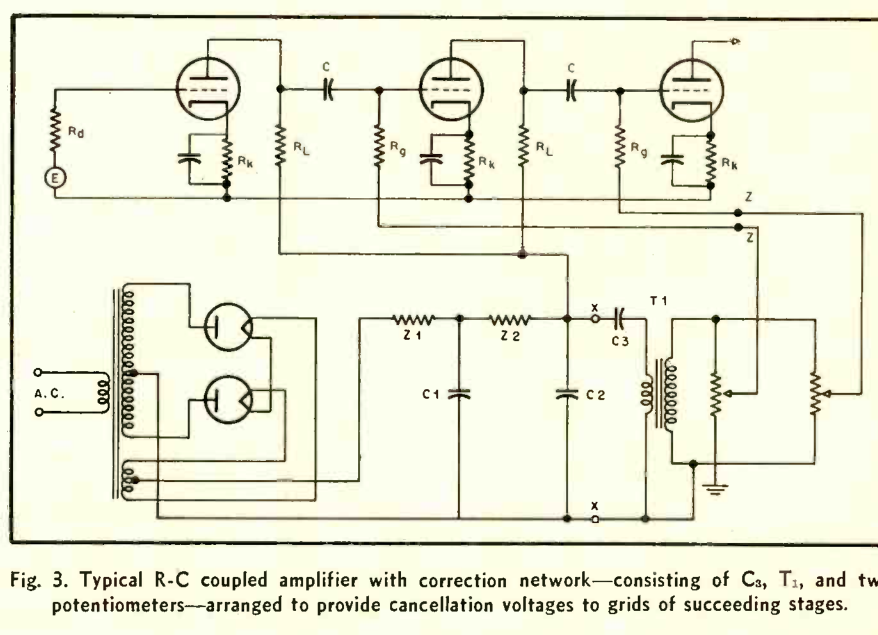


Fig. 3. Typical R-C coupled amplifier with correction network—consisting of C_3, T_1, and two potentiometers—arranged to provide cancellation voltages to grids of succeeding stages.

* *Signal Corps Engineering Laboratories, Fort Monmouth, N. J.*

Sensation in Bass!

EV FOLDED-HORN CORNER ENCLOSURES

Klipsch-Licensed Corner Horn Loading employs the walls of the room as an extension of the reproducer—assures one full octave of added bass range with unprecedented efficiency. Provides direct front radiation of high frequencies. Achieves smoother, cleaner, over-all musical balance. Authentically styled in fine veneers with lustrous hand-rubbed finish. Amazingly compact and moderately priced.

The BARONET. Designed for 8″ speakers. Response down to 35 cps. Conservatively modern, with graceful sloping front. 23½″ high, 14½″ wide, 10½″ deep at top, 14″ deep at bottom.
MAHOGANY. Cabinet only. List Price . . **$59.50**
BLONDE. Cabinet only. List Price **$63.00**

The ARISTOCRAT. Designed for 12″ full range speakers or for separate 2-way systems. Unusually smooth reproduction down to 35 cps. 29½″ high, 19″ wide, 16½″ deep.
MAHOGANY. Cabinet only. List Price . **$ 99.50**
BLONDE. Cabinet only. List Price **$106.00**

The ROYAL. Designed for 15″ coaxial speakers or for separate 2-way and 3-way systems. Laboratory flatness ± 5 db down to 30 cps. 37″ high, 20½″ deep, 23¾″ wide.
MAHOGANY. Cabinet only. List Price . **$180.00**
BLONDE. Cabinet only. List Price **$190.00**

800 CPS SEPARATE 2-WAY SPEAKER SYSTEMS

Super-Efficient Bass Combined with New Principle of High Frequency Dispersion

ARISTOCRAT I. includes E-V Model 108 Standard 800 cps Separate 2-Way Speaker System, completely wired and installed in ARISTOCRAT folded-horn corner cabinet enclosure. 29½″ high, 19″ wide, 16½″ deep.
Complete, in Mahogany. List . . **$265.00**
Complete, in Blonde. List **$271.50**

ARISTOCRAT II. Includes E-V Model 111 Deluxe 800 cps Separate 2-Way Speaker System, completely wired and installed in ARISTOCRAT folded-horn corner cabinet enclosure. 29½″ high, 19″ wide, 16½″ deep.
Complete, in Mahogany. List . . **$359.50**
Complete, in Blonde. List **$366.00**

ROYAL II. Includes E-V Model 114 Super 800 cps Separate 2-Way Speaker System completely wired and installed in ROYAL folded-horn corner cabinet enclosure. 37″ high, 23¾″ wide, 20½″ deep.
Complete, in Mahogany. List . . **$465.00**
Complete, in Blonde. List **$475.00**

Model 108 Standard 800 cps Separate 2-Way Speaker System. It consists of 12BW-1 L-F Driver, T-10 H-F Driver, 8-HD Diffraction Horn, X-825-1 Crossover Network, flat baffle board and AK-1 Accessory Kit of mounting hardware. 27″ high, 18″ wide, 12½″ deep.
List Price, less cabinet **$160.00**

Model 111 Deluxe 800 cps Separate 2-Way Speaker System. Consists of 12W-1 L-F Driver, T-25 H-F Driver, 8-HD Diffraction Horn, X-8-1 Crossover Network, flat baffle board and AK-1 Accessory Kit of mounting hardware. 27″ high, 18″ wide, 13½″ deep.
List Price, less cabinet **$255.00**

Model 114 Super 800 cps Separate 2-Way Speaker System. Consists of 15-W-1 L-F Driver, T-25 H-F Driver, 8-HD Diffraction Horn, X-8-1 Crossover Network, AK-1 Accessory Kit of mounting hardware, and flat baffle board. 33⅝″ high, 22¼″ wide, 13½″ deep.
List Price, less cabinet **$285.00**

RESEARCH-ENGINEERED
HI-FI SPEAKERS AND SYSTEMS
MICROPHONES
PHONO-CARTRIDGES
TV SELF-TUNING BOOSTERS
TV DISTRIBUTION SYSTEMS

Send Now for Bulletins!

Electro-Voice

400 CARROLL STREET • BUCHANAN, MICHIGAN

Export: 13 E. 40th St., N. Y. 16, U. S. A. Cables: Arlab

On a Budget

Jay Carver* and Cliff Howard*

A low-cost "housing" created by an architect who wanted his sound system installed in a mounting of unique—yet practical—design.

As designer-builders of custom sound systems, the writers often work with a very small budget. This stifles many an effort to create a form in color and material satisfactory to a particular individual. When equipment substitutions cannot be made, the compromise can be only in the cabinetry or the housing of the system. Still, like all problems, there is one satisfying solution—in our case, look for an architect-customer.

Here's a person with an awareness of unfamiliar materials. Further, his ideas on their uses are often far more varied and flexible. This happy realization came to us when we saw how one architect had packaged his sound system in a manner complementary to the rest of his home and of materials we had seen only in laboratories.

The most obvious compliment to the designing talents of this customer is the picture of the unit iself, which appeared last month on the cover of Æ, and as repeated in reduced size in the photograph above. An attractively simple, functional complement to the room's other furnishings, and fully commensurate with the quality of sound reproduction, it is a surprising combination of wood and metal. The unit contains the 20-watt amplifier, its remote controls, tuner, and—under its plastic cover—the record changer. The speaker is in another part of the room (though still facing the best listening sections) in a six-foot high bookshelf constructed of the same wood planks and aluminum rods.

Surprisingly, the complete unit is sturdier than a comparable wood cabinet, the rods being locked together with aluminum connectors of a type used on medical and photographic equipment. A screwdriver is the one assembling tool required. The audio equipment is mounted on H-shaped frames standing on the lower shelf of the enclosure. That enclosure uses metal grill work at either end, providing better heat dissipation for the amplifier and tuner than any other arrangement we've known.

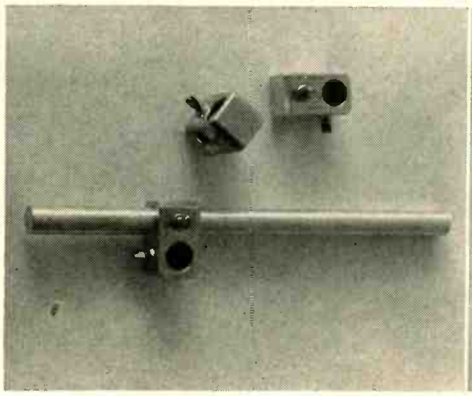
Here, then, is an outstanding example of what we consider an ideal sound system. Its components are among the finest available today. Their arrangement is a practical one. The system housing is exactly as the customer wanted. And without any great knowledge of audio equipment, he well demonstrates his understanding of the three major problems of housing any type of equipment—heat dissipation, accessibility, and availability for maintenance. (We recently checked over the entire system and the job required minutes rather than hours of our serviceman's time.) Budget requirements, of course, were extremely important in his final choice of form and materials. All of which pretty well describes anyone's reasons for housing his own sound system—lack of money, experience in design or related fields, perhaps a refusal to accept the mundane expressions that characterize much of today's production furniture.

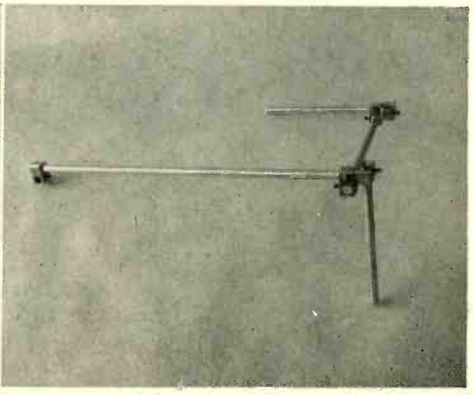
After the decision to build, the next choice was one of materials. The determining factor was matching the existing room designs and colors. In this particular home, extremely large tables serve also as work spaces, so they are natural-finish wood slabs mounted atop black-painted sawhorses. The other pieces are representative of the best in furniture design—simple of construction, beautiful of form and finished to display the beauty of the woods used.

But the bookcase—at least until the sound system appeared—was one of the dominating features of the living room. Its shelves are two-inch maple slabs, mounted on the same type of scaffolding as the sound unit. That design was obviously the most practical to be found for that home for a number of reasons. For shelving, any fine wood would do. The scaffolding can be extended in any direction, with only a screwdriver and more tubing needed. No expensive cabinet-making required, just a careful carpenter to cut the shelving and finish the edges. And, though we haven't as yet priced the connectors, we're certain that a dollar can buy two or three. As for the tubing, aluminum is the lightest of the usable metals and the best worked. Unfortunately, there is currently some shortage of this metal. But fortunately, this design isn't necessarily

[*Continued on page 52*]

* *The Electronic Workshop, 351 Bleecker St., New York 14, N. Y.*





A simple framework of rods held together by means of adjustable connectors serves to provide the builder with unlimited design possibilities in housing his home music system.

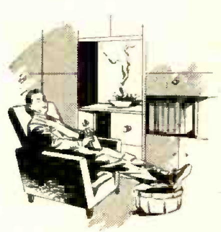
World Premiere — Chicago, May 19

STROMBERG-CARLSON

Custom Four Hundred

WIDE RANGE • HIGH FIDELITY

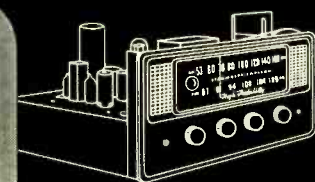
NOW, for the first time, a quality manufacturer tailors High Fidelity equipment to the *whole* market of home music lovers. Stromberg-Carlson's "Custom Four Hundred" line is backed by more than fifty years of audio engineering experience—years which have seen such pioneering "firsts" as the development of FM and the incomparable *Acoustical Labyrinth*—still a Stromberg-Carlson exclusive! To the man who knows electronics, this brand name is the unchallenged Finest.



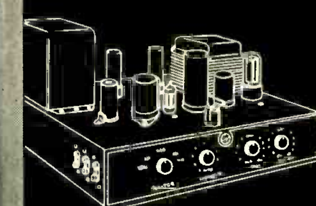
But Stromberg-Carlson realizes that "Hi Fi" has passed beyond the skilled-hobbyist stage—has become the fastest-growing trend in home entertainment since television swept the country. Therefore the "Custom Four Hundred" line is also available as a complete *packaged* installation for those non-technical home owners who are still looking for perfection in home music. Only demonstration can fully show the quality of the new line—and the Electronic Parts Show is the locale of the first such public showing. Don't miss it!

A COMPLETE LINE for the Audiophile, who wants to select the component parts and install them himself.

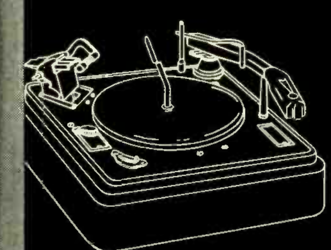
A COMPLETE OUTFIT for the Music Lover who wants to buy it as a "package" and have his dealer install.



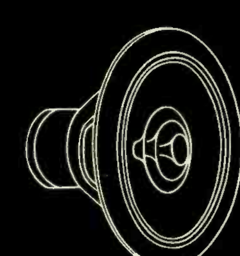
Custom Four Hundred
AM-FM Tuner



Custom Four Hundred
Amplifier, 10w & 25w



Custom Four Hundred
Garrard Changer



Custom Four Hundred
Coaxial Speaker

PLUS A CHOICE OF CABINETS FOR CUSTOM INSTALLATION

DEMONSTRATION EXHIBIT
Conrad Hilton Hotel • Rooms 619 A and 620 A

STROMBERG-CARLSON
Sound Division • Rochester 3, New York

Cabinet Design for Hi-Fi Systems

Jeff Markell*

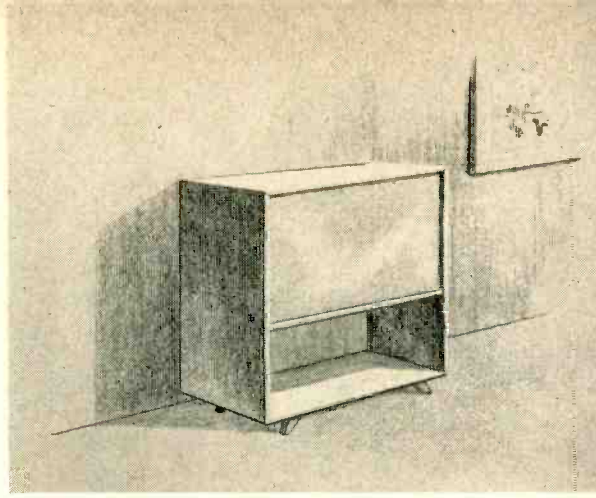


Fig. 2. Same basic cabinet as that of Fig. 1, but with a different design treatment which provides for considerable record storage.

A frank and thorough discussion of the design aspects of cabinets for housing the elements of a high-quality home music system.

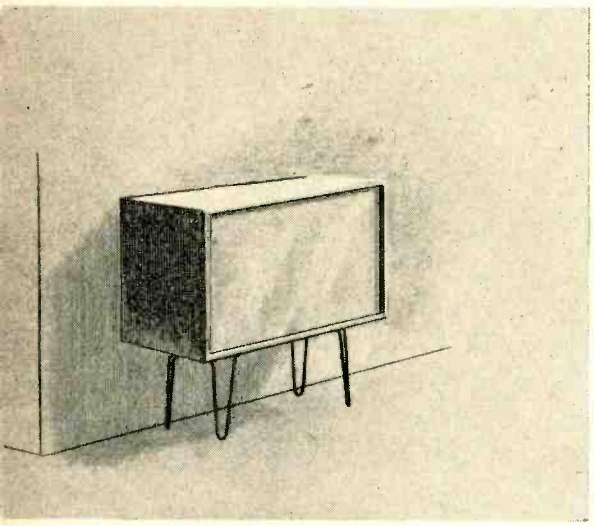


Fig. 1. Simple design for housing all the necessary components except the loudspeaker. All figures are original designs by the author.

Most of us at one time or another have had the thrilling experience of entering a friend's living room, and being faced almost immediately with a large block of fir plywood stained mahogany which very closely resembles nothing more than a block of fir plywood stained mahogany. When a cursory inspection has revealed that this construction—if we may use a term loosely—has obviously been conceived and assembled by a third-grade manual training class, we can be fairly certain that our original assumption was correct—namely, that our friend is the proud possessor of a high-fidelity system.

In all probability we will have an opportunity to enjoy some excellent music in the course of the evening. This is a not inconsiderable value. However, the question arises as to whether it is either necessary or desirable that a beautiful voice be housed in an ugly carcass. The answer is, of course, a resounding NO.

It would seem reasonable to expect that, if we can deal successfully with the numerous problems involved in constructing systems for high-fidelity sound reproduction, it should not be too difficult to house this system in a relatively presentable fashion. Basically you can house your equipment in one of two ways only. You can either build it into the dwelling unit, or you can build a piece of furniture around it.

It is the purpose of the present discussion to deal only with the furniture cabinet type of installation for the reason that built-in installations are necessarily of a highly individual nature, largely dependent upon the character of the dwelling unit involved, and therefore cannot be considered in general terms.

Before launching into such questions of cabinet design as dimensions, materials, construction, styling, finish, and so on, it would seem well to take first things first by noting the components to be housed along with the conditions and considerations they will impose individually on the design of suitable cabinets.

The following list of common components will be news to no one:

a. Changer
b. Tuner
c. Amplifier
d. Speaker

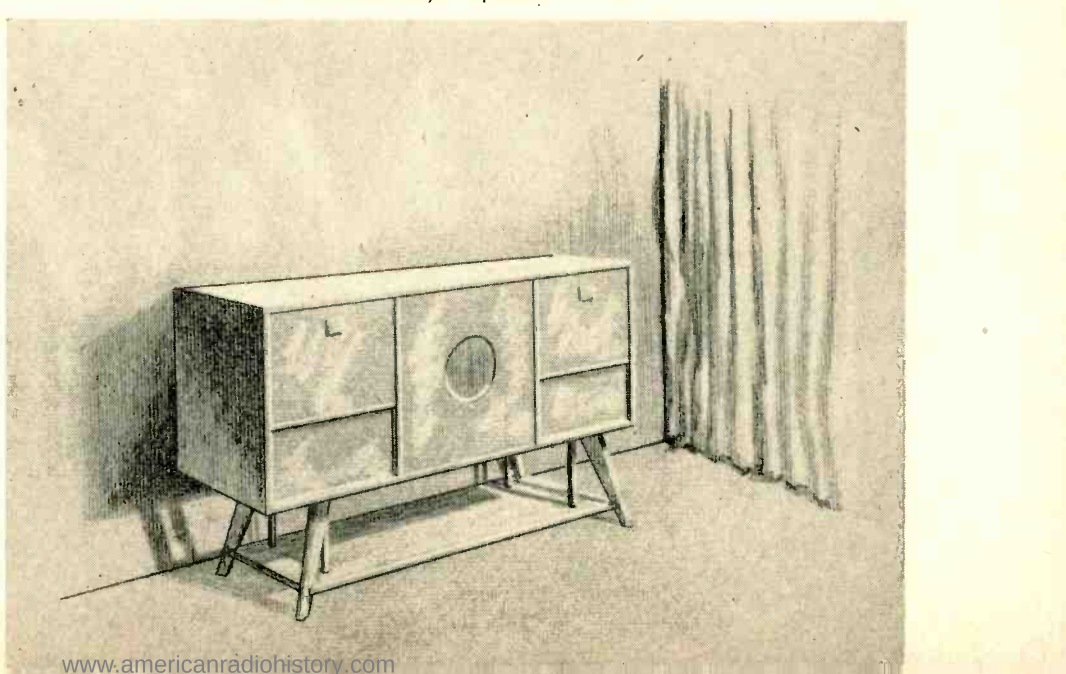
In some cases, the amplifier will consist of a single chassis which includes preamplifier and power supply. In others, as many as three separate chassis may be used. In such cases the preamp, because of its controls, must be considered as a separate component for cabinet design purposes. However, since power supplies do not have to be adjusted from the control panel, they can be lumped with amplifiers.

Changers are more often than not the largest single components in terms of cubic volume required for mounting (excluding speakers, of course, which require a separate discussion). Because of its depth, the changer is generally the determining component for minimum cabinet depth. A 16 × 16-in. mounting board will be adequate for any of the currently popular changers, and will allow sufficient room for changing of records and access to controls.

The changer mounting board should generally be fixed at a height of approximately 30 in. or more above floor level in order to avoid the need for stooping. It should be mounted no higher than 48 in., but a cabinet this high is distinctly unlikely.

A safe minimum allowance below the

Fig. 3. Expanded cabinet design which provides for the speaker in addition to the other necessary components.



* *108 W. 14th St., New York 11, N. Y.*

Prepared from a paper given at the Third Annual Convention of the Audio Engineering Society, Nov. 3, 1951.

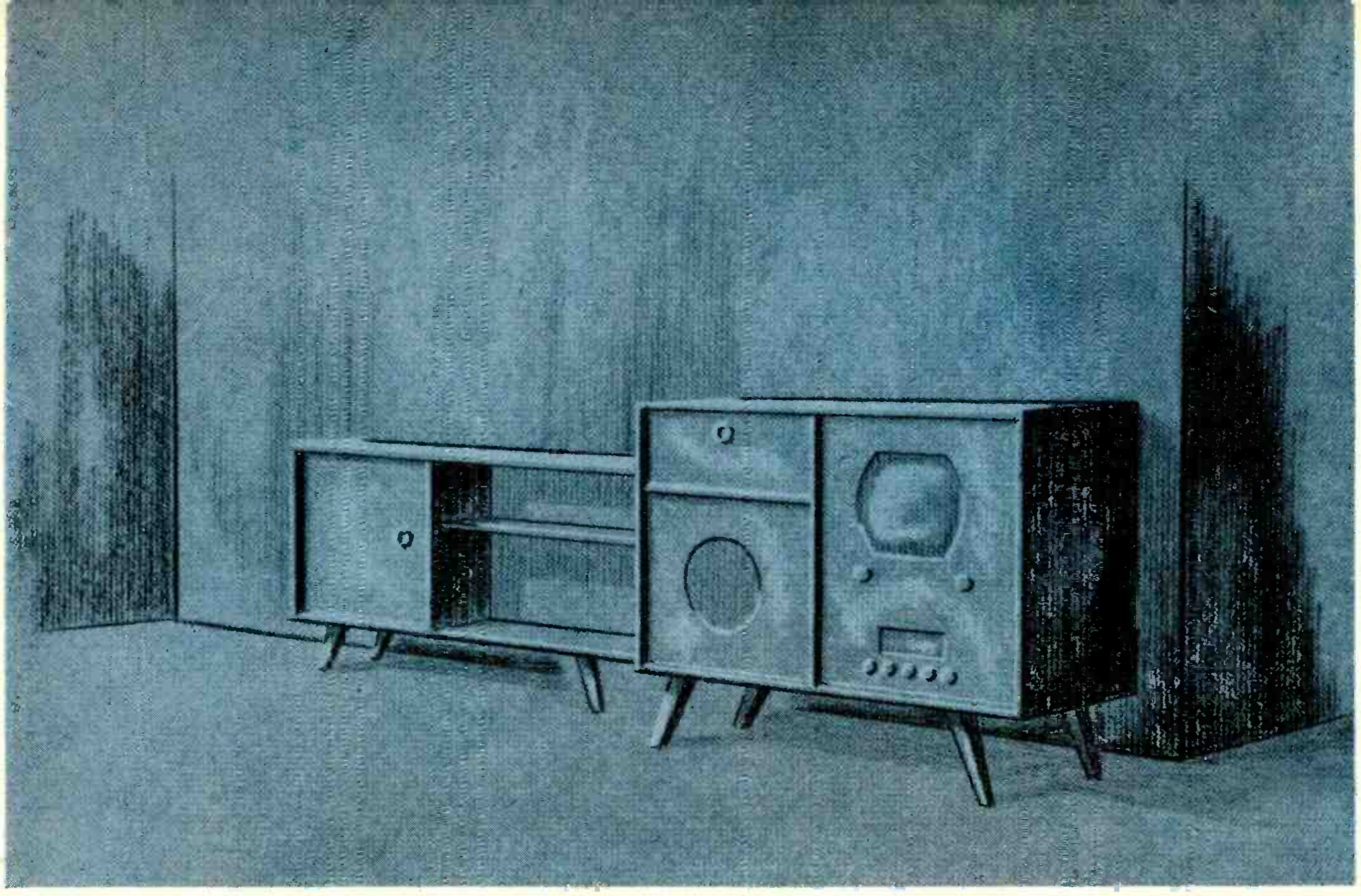


Fig. 4 (above). Increasing the over-all size by the addition of book and record shelves and a section which might be used as a bar provides a fairly complete entertainment center. Fig. 5 (below). A more conventional design than that of Fig. 4, and yet providing for all of the necessary elements, plus a desk or storage unit.

mounting board for all types of currently available changers is 4 in. Allowance above the mounting board for lid-opening enclosures can be as little as 6 in., but door-opening or drawer-opening enclosures should allow an inside height above the mounting panel of at least 8 to 9 in. to permit convenient insertion and removal of records.

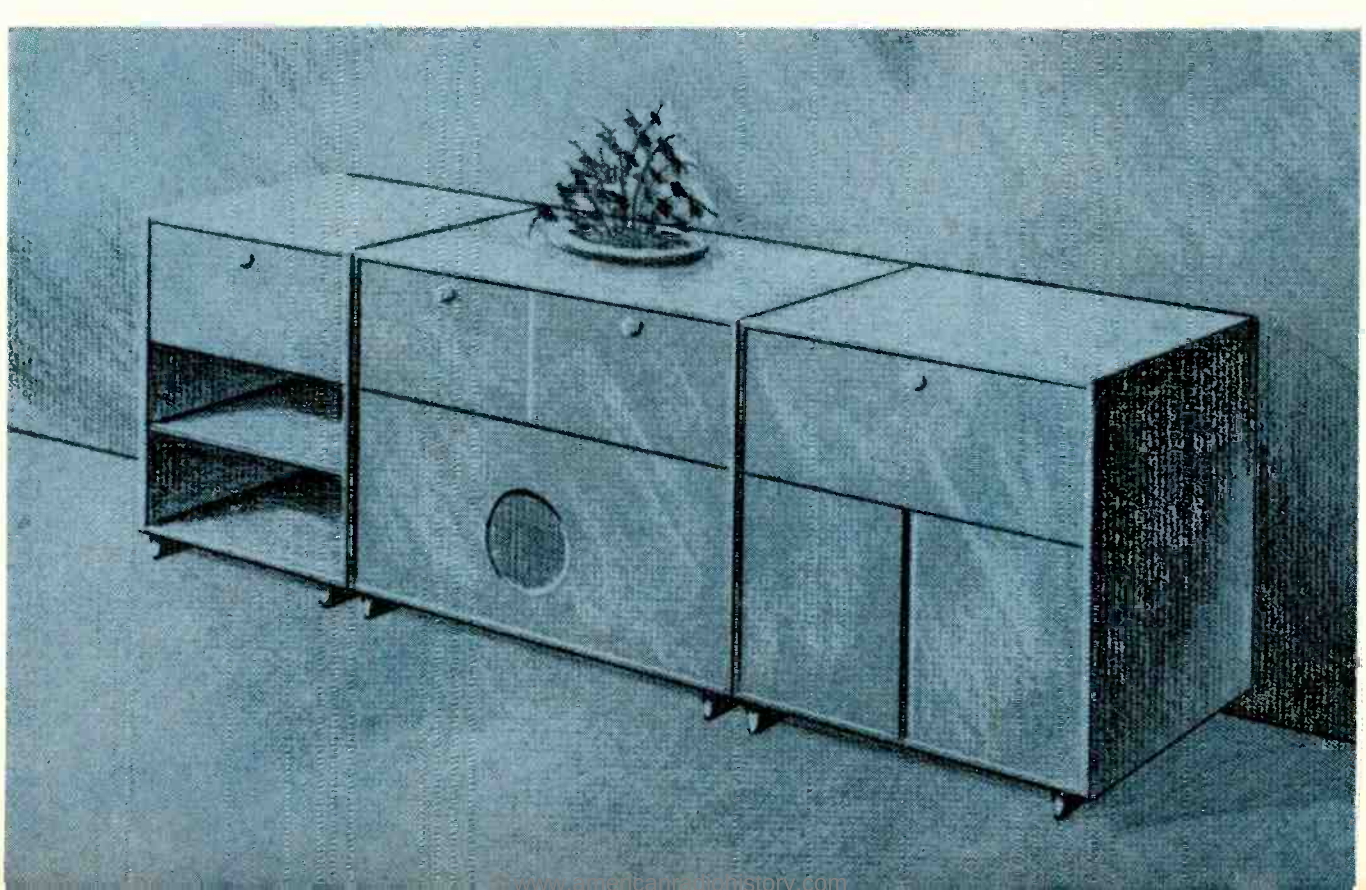
Radio Tuners and Amplifiers

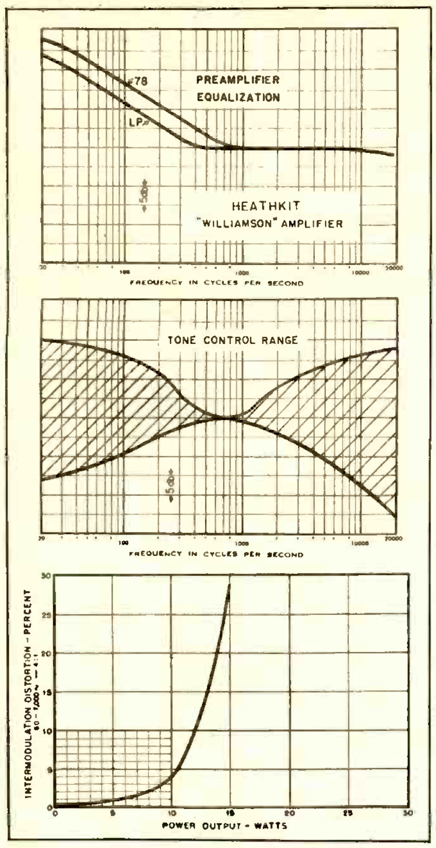
Tuners for high-fidelity systems are generally AM-FM types. An enclosure behind the control panel measuring $17\frac{1}{2} \times 12 \times 10$ in. inside will suffice for mounting even the largest of the currently available makes. Many of the tuners most popular at the present time will fit comfortably in a space $14 \times 10 \times 10$ in., but when designing for general use rather than for a specific chassis, it is undoubtedly safer to allow $17\frac{1}{2}$ in. rather than 14 in. inside the front. Furthermore, the differential in cost for the additional $3\frac{1}{2}$ in. of cabinet will not be significant unless it runs the over-all width of the cabinet over the nearest even foot.

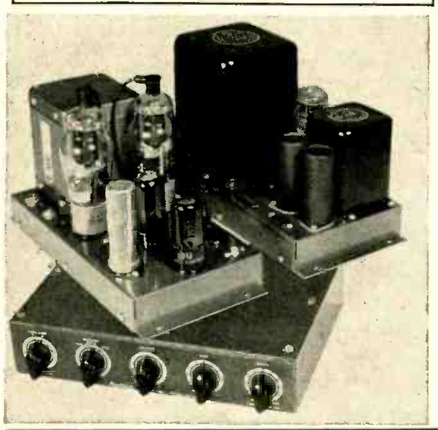
In order to have the tuner dial and controls most easily visible and accessible, it is again well to mount them about 30 in. above floor level. This usually places the tuner in the completely unoriginal but perfectly practical position of being alongside the changer.

Amplifiers vary quite considerably in size. Some are appreciably smaller than the smaller types of tuners, while others are quite as large as the largest types. This tends to make it difficult to standardize on a set of dimensions to be allowed for the amplifier space. However, the largest amplifiers will fit in about the same space as was allowed for the largest tuners, namely $17\frac{1}{2} \times 12 \times 10$ in.

[*Continued on page 38*]







Equipment Report

Heathkit WA-A1 Williamson-type Amplifier

EASILY THE MOST economical way to obtain a high-quality amplifier, the Heathkit WA-A1 main amplifier and power supply in combination with the WA-P1 preamplifier measures up to the performance requirements for a satisfactory home system.

The complete amplifier includes a control unit and preamplifier which is 2¼ in. high, 10¼ in. wide, and 7¼ in. deep, and which connects to the main amplifier by two cables—one which provides plate and filament power as well as the a.c. leads to the power switch, while the other is a co-axial lead for the signal. The preamplifier utilizes the two halves of a 12AX7 or 12AY7 in a conventional equalized feedback arrangement with two turnover frequencies—400 and 800 cps, labeled on the control panel as LP and 78 respectively. The second tube in the control unit provides sufficient gain for the tone controls.

A total of five controls are employed—turnover frequency for magnetic pickups, a selector switch with three positions (magnetic, crystal, and radio), a volume control combined with the a.c. switch, and separate bass and treble tone controls. The amplifier is supplied in kit form, and requires somewhere around four to six hours to assemble.

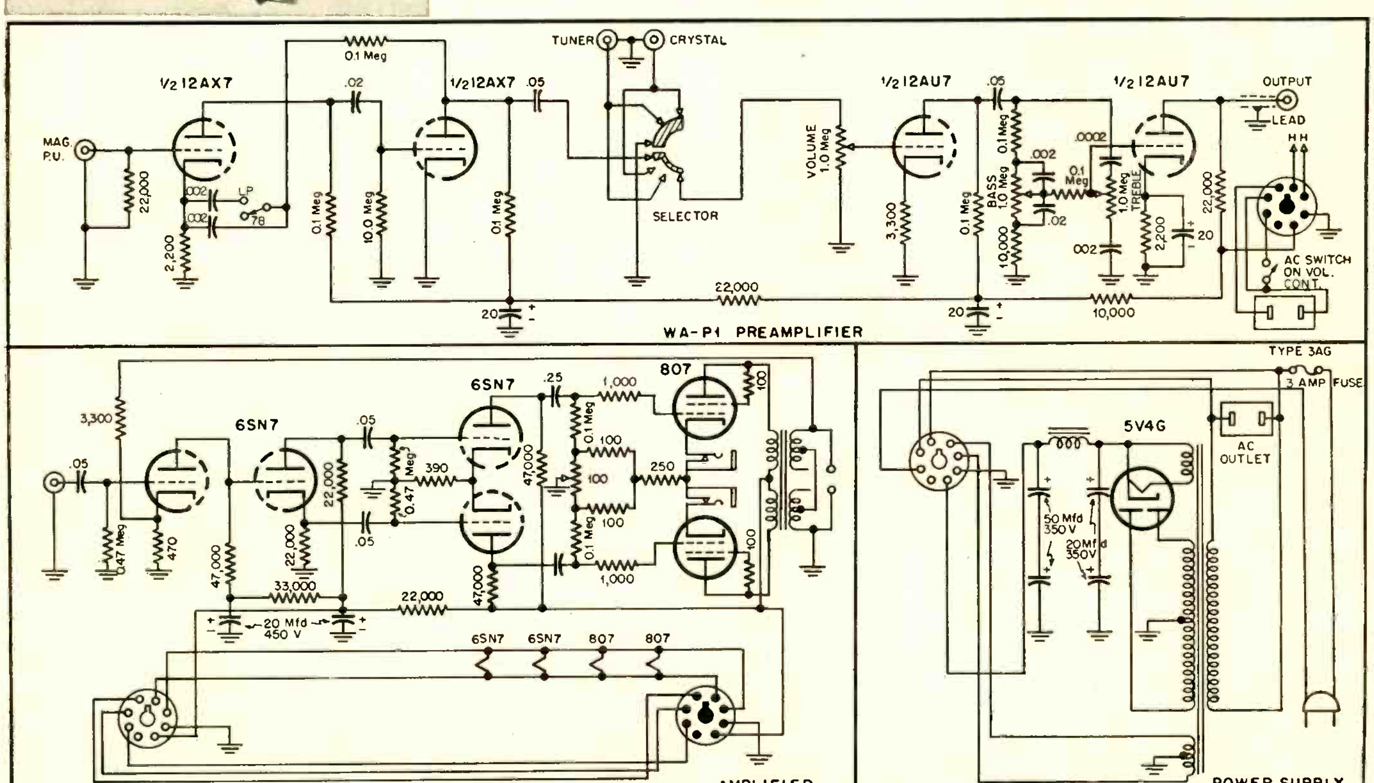
The selector switch is so arranged as to short out the radio and crystal inputs when playing records with a magnetic pickup, thus silencing the tuner completely without any further switching. Bass and treble tone controls are non-interacting, and the curves provided work out well from the listening standpoint.

The power supply and the main amplifier are on similar chassis, 5½ x 11, and the maximum height is 7 in. The output transformer is a special unit made by Peerless for this application, and the power transformer and filter choke are both Chicago Transformer products. The circuit of the main amplifier is essentially identical with the now-famous Musician's Amplifier, first introduced in Æ in November 1949.

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

Input	Voltage
Mag. PU, 78	.0024
Mag. PU, LP	.0028
Crystal	.08
Radio	.08

Response and distortion curves for the Heathkit Williamson-type amplifier (left) and the complete schematic of the three sections (below). Note a.c. outlets on both preamp and power supply to provide for tuner and phonograph turntable.



NARTB Conference and Exhibit

Broadcasters meet in Management and Engineering Conferences with television stressed by both groups. Convention marks 30 years of association for betterment of the industry.

WITH GOOD FELLOWSHIP and a general spirit of anticipation of better years ahead, the 1952 Convention of the National Association of Radio and Television Broadcasters showed a considerable improvement over the previous two meetings.

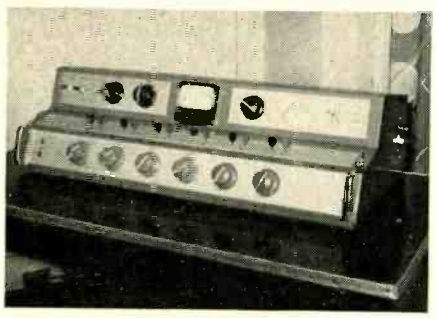
The onlooker would immediately recognize a more optimistic outlook this year than was apparent in either 1950 or 1951, and all who attended came away feeling that new life had been injected into the organization. The long-anticipated lifting of the freeze was expected momentarily—and the convention was followed on April 14 by the official order of the FCC which terminated the period during which no applications for TV licenses were accepted.

Because of the strong slant toward television, the papers presented at the technical sessions offered little material for the audio engineer—but the two papers on audio that were given described lines of equipment destined to find their niche in the broadcast or recording studio.

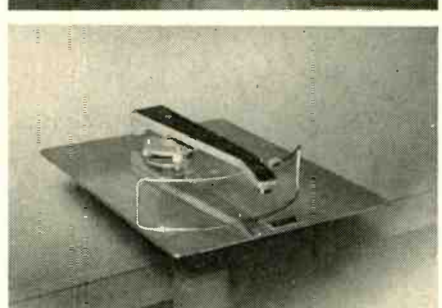
Norbert Jochem, chief audio engineer of Gates Radio Company, presented a series of amplifiers and power supplies which can be used as building blocks to assemble speech input equipment for stations of all sizes. Performance and compactness have been combined in preamplifier, line amplifier, and power supply chassis units which plug in to shelves designed for mounting on a standard rack panel.

John Hilliard, chief engineer of Altec Lansing Corporation, described a new series of plug-in consoles in which all amplifier and power-supply units were contained within the console itself. With such an installation, no additional equipment is required, and while several standard arrangements of equipment are offered, special units can be built readily for particular applications.

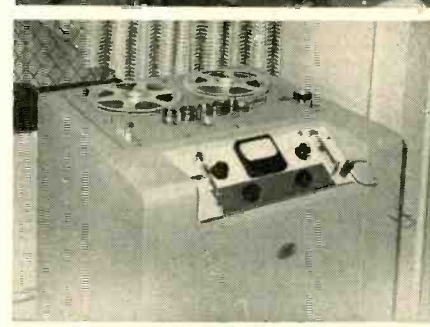
In the equipment exhibit, tape recorders—as usual—took the spotlight. Ampex displayed a new console recorder selling for less than a thousand dollars, and the Stancil-Hoffman Minitape recorder earned its keep by being demonstrated throughout the exhibit. RCA's new fine-groove transcription turntable provides a specialized companion piece to standard models, with design features which make for easier handling of LP and 45-rpm records. Magnecord demonstrated the new "ears"—which permit the use of 10-in. reels on the standard model—to broadcasters for the first time, and Gray Research and Development Company exhibited a professional pickup arm in the audio line along with a more compact Telop II in the TV equipment line.



Top to bottom: the Altec console, Ampex's new console recorder, and Federal Telephone and Radio's impressive end-of-corridor exhibit.

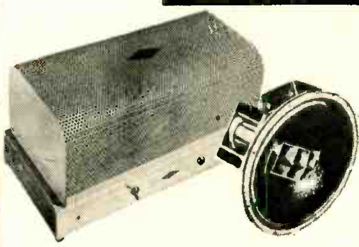


The Gray transcription arm, above, and Gates' Wally Karrick with one of the new plug-in amplifiers.



Top to bottom: part of Magnecord's exhibit, which included a binaural demonstration; Mississippi broadcasters Cy Bahakel (left) of WKOZ in Kosciusko and Charles W. Holt of WHSY in Hattiesburg learn about the Minitape; Presto's medium-priced console recorder; and RCA's new fine-groove transcription turntable.

HARVEY for the finest in sound equipment



STEVENS 500-D DIRECT DRIVE AMPLIFIER

The first commercial amplifier without an output transformer. High damping factor. Frequency response: ± ¼ db 20-70,000 cps. Distortion less than ½ of one percent at full 20 watt output. Phase shift less than 15 degrees at 20 cps. **$135.24 Net**

The 5106AX, a new 500 ohm voice coil co-axial speaker. The perfect companion for the 500 D Amplifier. SPKR — 5106AX. **$131.57 Net**

"Wireless" VOCATRON INTER-COM

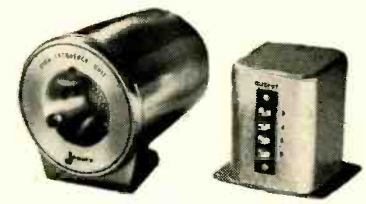
No wiring needed. Just connect to power-plug . . . talk and listen. Ideal for homes, offices, stores, factories, farms, etc. Weighs only 3½ pounds. AC-DC operation.

$79.50 per pair of listen-talk unit. Extra units, $39.75 ea.

THE BOGEN BATON

A complete high fidelity amplifier system consisting of Model H010 All-Triode Main Amplifier and Model RXPX Pre-amplifier and Remote Control. Main Amplifier provides peak 25 watt output with .3 of one percent distortion at 10 watts. Frequency range at 10 watts is ± .2 db, 10-20,000 cps. and ± 1.8 db, 10-50,000 cps. Pre-amplifier has inputs for AM, FM, TV and All Popular Phonograph Cartridges. Remote Control has 25 foot single cable connector to main amplifier and independent controls for power, volume, bass, treble and phono turnover frequencies. UL approved. Complete with Tubes and Remote Control, Pre-amplifier. **$147.15 Net**

JENSEN RP-302 HIGH FREQUENCY UNIT



Makes a 3-Way System From Your Present Coaxial, or a 2-Way from a Single Unit Direct Radiator.

This compact "super tweeter" originated in the h-f channel of the famous Jensen G-610 Triaxial. Makes an excellent "top end" for custom-built multi-channel systems. No installation problems. Simple to mount. Provides smooth, clean highs from 4,000 to approx. 18,000 cycles with extremely low distortion. ***Model RP-302 $32.93 Net***

JENSEN A-402 CROSSOVER NETWORK. Designed for 4,000 cycle crossover. Ideal for use with RP-302 and your present speaker system. Full 180 degree constant-resistance type. Impedance, 16 ohms at input and outputs. ***$6.61 Net***

THE NEW MAGNECORDette

A Distinctive, Professional TAPE RECORDER. Designed and Priced for the Home!

RECORDING SPEEDS: 15 inches/sec., or 7½ inches/sec. interchangeable. (No tools required.)
REWIND SPEED: Full 7½ inch reel (1200 ft. of tape) rewound in approximately 40 seconds.
FREQUENCY RESPONSE: At 15 inches/sec.: from below 50 cps. to 15 kc ± 2 db. At 7½ inches/sec.: 50 cps. to 7 kc ± 2 db. when the proper equalizer for the specific speed is used in the amplifier.
FLUTTER: Max. 0.3%.
MOTORS: Synchronous 117 V 60 cycle AC drive motor. Shaded pole motor for rewind.
POWER REQUIREMENTS: 117 volts 60-cycle single-phase AC 70 watts.
DIMENSIONS: 12½" L x 20½" W x 16" D.
PANEL: Magnecord grey hammered finish.
BIAS OSCILLATOR: Built in. Uses single 12AU7 tube. 6.3 at .3 amps and 300 V at 40 ma supplied from amplifier.

Simple to operate, beautiful to own, professional in quality . . . you'll be proud of your new MAGNECORDette. In stock for immediate delivery .... **$385.00 Net**

10½-INCH REEL ADAPTER MECHANISM

Can be attached simply and easily to all MAGNECORD and MAGNECORDette Professional Tape Recorders. Complete record playback, rewind and high speed forward is possible with 10½-inch reels. In stock for immediate delivery.... **$35.00 Net**

WEATHERS Variable-Capacitance FM PICKUP

Tracks at a stylus pressure of only one gram when mounted in a good arm. Can be installed in Webster changer in place of present cartridge with stylus pressure as low as three grams. Record wear virtually non-existent. Frequency response is 20 to 20,000 cycles.

W-202-T . . . Cartridge set with truncated sapphire stylus for all micrograove and standard 78 rpm records .... ***$38.50 Net***
W-202-1M . . . Cartridge set with 1-mil sapphire stylus for 45 and 33⅓ records .... ***$37.50 Net***
W-202-3M . . . Same with 3-mil Stylus for 78 rpm records ***$37.50 Net***
W-22 . . . Power Supply .... ***$14.50 Net***

HARVEY'S New Catalog of High Fidelity Equipment is NOW AVAILABLE! Write Dept. A5

VISIT THE AUDIOTORIUM. Come in and visit our new sound department . . . all these items and many more on working display at all times.

Telephone LUxemburg 2-1500
HARVEY RADIO COMPANY, INC.
103 West 43rd St., New York 18, N. Y.

NOTE: In view of the rapidly changing market conditions, all prices shown are subject to change without notice and are Net, F.O.B., New York City.

EDWARD TATNALL CANBY*

More than an Earful

THIS MONTH I tried writing record reviews *before* getting to my introductory "article" — with the inevitable results printed below. There ain't no end to record reviewing these days (the one-man reviewer is just about overwhelmed) and so I devote the rest of this space to records. This month's format, listing records with incidental comment on them, is definitely favored by many of our readers, space or no. It caters more to those who are primarly interested in the music, with good technical quality a secondary necessity, than to our out-and-out hi-fi fans.

Interest being evenly divided, in future issues I'll also print lists of recommended records with technical key but minus comment, as in past issues, to supplement the written-out reviews as below. We'll use the two systems as the situation seems to warrant. We aim to satisfy the hi-fi fans too, to the best of our abilities.

Key

* **Outstanding recorded sound for the type of music.** [c] Close-to, sharp highs. [d] Distortion shows up in highs. [f] Flattish high end; needs boost over normal LP playback. [h] Heavy, high-level cutting. [l] Live, rather distant pickup. [m] Hum in the recording. [o] From older 78 originals. [x] Weakish bass, will need boost over normal LP playback. [y] Highs lacking.

Not-so-light Popular

[l] **Gershwin, Rhapsody in Blue; An American in Paris.** Paul Whiteman & anon. orch., Leonard Pennario, piano. **Capitol P-303**

[o] **Gershwin, Rhapsody in Blue** (condensed). Paul Whiteman & His Concert Orch. George Gershwin, piano. **RCA Victor: 45: 27-0149** (Recorded April, 1927)

* **Curtain Time.** Morton Gould & His Orchestra. (8 arrangements.) **Columbia ML 4451**

Here are the two outstanding masters of the curious music 20th-century America has brought forth from popular and light-opera fare almost—but never quite — into the so-called "classical" area. In any other age both would surely have been leading composers of a great variety of music; probably every bit of it would now be decidedly classical in the best sense.

The "FDS" Capitol Gershwin record has a fine sound but an inappropriate one altogether, to my ear. Too classical, too big-time; the orchestra enormous, at a great distance, the whole mellowly blurred, the details quite lost—those sharp, cutting edgy little figures that are G. at his best. This one-mike (probably) very live technique is the antithesis of the 1920's! If you want the right technique, listen to Whiteman and G. himself in the old 1927 version — dry, closet-like, but even minus highs it has the true feeling of the 20's, dry, witty, elegant, satirical! If you're going to have short skirts in music—you gotta show those legs.

Gould, of a later generation, takes to big-hall recording much better (and his is a sweeter balance too, with every electrical gadget you can ask for and probably six dozen mikes). These are straight show tune arrangements but like all Gould, they edge tantalizingly into the really good classical. That is, Gould's real musical genius grasps at every twist and turn of an idea in these tunes and makes something of it, in the way of musical display, development. His is a subtlety of harmony and of instrumentation that is like Ravel's and as potent. The display of sheer musical power, spent upon these semi-routine tunes, is worth any musician's study—and yet . . . as always, Gould never rises more than just a mile or so above the utterly commonplace, just barely scrapes along the edge of really permanent musical thinking. So much, and yet so little. Absolutely gorgeous recording and playing.

Korngold by Korngold. Erich Korngold, piano; Austrian State Symphony, members of Austrian State Opera. **Masterseal MW 46**

Here's another might-have-been 20th-century master: in his early youth he was acclaimed and aided by such men as Mahler, Bruno Walter, Schnabel. At 11 and 13 his piano works (two movements here) were certainly unusual, if strictly imitative of Rachmaninoff, Schumann, etc. But the later stuff is just heavyweight light opera. Musical, yet without a trace of the originality of Gershwin or Gould in the way of harmony. He improvises here on his famous tunes at the piano, conducts other orchestral excerpts, one with voices. Excellent piano recording and good orchestra. A sad tale, if you ask me.

(Masterseal is the de-luxe Remington edition—on good plastic with incredible covers of pseudo alligator and shark skin!)

The Seventeenth Century

[yd] **Purcell, Timon of Athens (Musick for the Masque); The Fairy Queen.** Orch. of L'Oiseau-Lyre, Lewis. Margaret Ritchie, sop. **Oiseau-Lyre LD-16**

[f] **Purcell, Dido and Aeneas.** Complete opera. Stuart Chamber Orch. and Chorus, Gregory. **Period SPLP 546**

Henry Purcell, of the 17th century, was a lusty yet introspective composer who ranks as England's greatest. His music was buried for long under Handel's—who came just after him—but now is increasingly recognized for its greatness. Very British (far more so than Handel), with poignant dissonant 17th-century type harmonies, plenty of broad British tunes. If you like Gilbert & Sullivan you'll find Purcell congenial! Few performances hit the right tone—the two above do. "Dido," first complete British opera, is beautifully done here by understanding English performers, the famous lament movingly sung by Eleanor Houston.

The French recording gives the incidental music for an early Masque (a sort of serious musical-comedy of the time) plus the same for a stunningly fine late Purcell work, The Fairy Queen, with another lament that tears at the heart, plus much instrumental ballet music. One voice, a good high soprano.

Both records are under par technically. The British "Dido" is good with flat high end, no roll-off; acoustics somewhat dead and studio-like. The French LP (made and pressed in France) has highs, pre-emphasis, but is dreadfully distorted in many spots. Even so, easily listenable. France is still behind.

[d] **Purcell, "Great" Chaconne in G (arr. Whittaker); Nine Four-part Fantasias; Fantasia upon One Note.** Vienna Chamber Orch., Litschauer. **Vanguard VRS 420**

[d] **Purcell, "London" Chaconne; Three-part Fantasias.** Vienna Chamber Orch., Litschauer. **Vanguard VRS 419**

Amplifications for string orchestra of instrumental works for fewer strings, these are, except for the "Great" Chaconne arrangement, good realizations on a larger scale of this extraordinary music—serious, modest, unassuming but full of strange, experimental dissonances typical of the 17th century and of Purcell at his best. The tremulo of the strings is a bit annoying but the spirit of the playing is excellent. The "Great" chaconne is fixed up by Whittaker with octave doublings that make it sound anachronistically like Brahms or Mendelssohn. Awful. The "London" is superb. Good recording, a trace of distortion, not enough to bother.

[d] **Purcell, King Arthur.** Solo voices and chorus dir. Fritz Kramer **Magic-Tone MLP 1006**

[*Continued on page 34*]

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

". . . A month ago I was fortunate enough to receive an AUDAX CHROMATIC as a birthday gift. The total absence of needle-talk and the superbly smooth musical quality are a constant delight. Now my new records stay new. As a photographer, I know that the lens makes or mars the picture. Just so, the reproducer makes or mars the music . . ." *(from a letter)*

The lens makes or mars the picture, the reproducer makes or mars the music.

The revolutionary new records are so true to the original that almost any pickup is bound to give some results . . . but—it takes a reproducer of the highest order, one sensitized to the *nth* degree . . . a *Chromatic Polyphase*—to bring out every subtle shading, every nuance so essential to the real music of which these discs are capable.

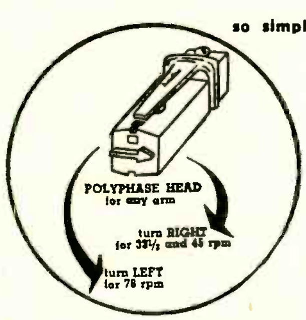
with the new Compass-pivoted Audax arms and for Record Changers.

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

•

Special models for radio stations, including Vertical-Lateral units

so simple



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

Write for editorial reprint on POLYPHASE Principles

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

AUDAK COMPANY

500 Fifth Avenue New York 36

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

"The Standard by Which Others Are Judged and Valued"

RECORD REVUE

[*from page 32*]

A weird affair this, but not without value. Anonymous solos, an electric organ and a piano plus an occasional chorus—budget opera with a vengeance! But (maybe by sheer luck) the director definitely knows his Purcell and puts his hackish artists through some good paces, notably the lady singer (the tenor can't sing on pitch), and the chorus. The only recording of an important work.

Purcell, Te Deum; Jubilate in D; "Bell" Anthem; O Sing Unto the Lord. Purcell Performing Society, Old Stone Church Choir, orch. cond. John Reymes King.
Allegro alg 3027

In spite of the fancy designations here, these performers do a very mediocre job for Purcell. The instruments aren't terrible, but the big, wobbly solo singers are; not an ounce of the vigor and warmth that the music so obviously has in it. *"Rejoice in the Lord, Alway"*—and these voices mumble the inspiring words like so much mashed potatoes!

Purcell and others: Catches and Glees of the English Restoration. Male Quartet.
Allegro alg 107

The texts of these, printed in full on the cover, are—if one reads but *very* slightly between the lines — the bawdiest good naturedly suggestive English I have ever seen. Nice. These are mostly little rounds and canons for the equivalent of male pool parlor or club singing. A bit too operatic in tone for my taste here, since the music is hardly big-voice stuff.

* **Buxtehude, Five solo cantatas for soprano.** Margot Guilleaume; Instr. Ensemble of the Bach Anniversary.
Vox PL 7330
m **Buxtehude, Missa Brevis; In Te Speravi, etc.** Hastings Chorale, John Bath.
Allegro alg 3035

Buxtehude, the greatest North German just before Bach (he died 1705 when Bach was 20) is not as easy to get on first hearing as Purcell, but Bach lovers (and Handel) will catch on fast. The solo cantatas are excellent here, far superior to the Patricia Neway performances on Allegro; recording is excellent too. The Missa Brevis, composed outwardly in the older "Palestrina" style of unaccompanied voices, is actually easier for us to understand. A somewhat chastely British singing with much echo and an odd balance in the acoustics; the other pieces feature a male "countertenor"—falsetto—among the soloists, plus an inconsistent piano in one piece, harpsichord in another. I'd give this a qualified OK. Recording is fair; background hum in some places.

* **Schütz, Musicalische Exequien (German Requiem).** Cantata Singers, soloists, Arthur Mendel.
R.E.B. #9
* **Schütz, St. Matthew Passion.** Stuttgart Choral Society, soloists, Grischkat.
Renaissance SX 203 (2)

Schütz, earlier than Buxtehude (above), is now coming into his own—as a superb master of the spoken word in music. His music is almost meaningless unless one follows the text, phrase by phase, both for the shape of the language, the phrases, the rhythms of it, and for the underlying meaning. These two are both top quality jobs in this respect. The "Exequien" (Requiem) is a complex and brilliant concerto for voices (with instruments), the solo group and chorus contrasted in dozens of ways; the fresh, enthusiastic speaking of the words by these singers makes Schütz exciting—where many an uncomprehending performance mumbles its way meaninglessly along. Follow this text in hand (it's provided) and you'll see. The St. Matthew Passion, a more strict form without instrumental accompaniment, suggests the Bach passion, but the recitative (a lot) is unaccompanied solo. Text also provided and well spoken. Both records are beautifully recorded, the Stuttgart a bit better as to cleanness. (See also the earlier St. John Passion by the Stuttgart group.)

* **Monteverdi, Psalms: Beatus Vir, Laudate**

Dominum. Ut Queant. Choral and Instr. Ensemble Scuola Veneziana, Ephrikian.
Period SPLP 536

[d] **Schütz, Four Sacred Concerti; Four Symphoniae Sacrae.** Hugues Cuenod, members Vienna Symphony, Pinkham.
Westminster WL 5043

Early German Church Cantatas. Yves Tinayre, Allegro Chamber Society, White.
Allegro AL 79

[d] **Monteverdi, Tirsi e Clori,** etc. Max Meili, Elsa Scherz-Meister, Schola Cantorum Basiliensis. **Concert Hall CHS 1085**

Monteverdi, in Italy, was the first big man to write real solo music with instrumental backing. Using Italian and Latin, he is not far in style from the North German Schütz. All of these—coming from the U. S., Italy, Switzerland, Austria—feature solo singers, together and apart; they are best for those who are accustomed to the sound of such singing.

Most appealing is the Scuolo Veneziana job—beautifully fresh and clear voices, a larger body of strings, excellent diction, nice recording, lots of variety. The "Basiliensis" (Basle, Switzerland) group is similar, with all sorts of instruments—lute, recorders, etc.—but the sound is muddy, the diction not clear; a bit harder to take, in spite of excellent performance.

Hugues Cuenod and Yves Tinayre are tenors, their recordings are all-solo. Cuenod sings nasally but with vitality; Tinayre, an old hand in this game, is short of breath, exaggerates rather painfully. Fine music—but try these only if you can withstand the tonal sameness of one voice throughout.

Sacred Music of the 17th Century (England). Purcell Performing Soc., King.
Allegro alg 3038

Back to England—and to the wobbly solo voices of this Cleveland church choir. Intentions excellent, with authentic instruments, but this typically American solo approach is deadly! Again—mashed potatoes. The music is superb, comes through if you can hear "through" the surface. Gibbons (a very great British composer) and two lesser big men, Philips and Locke.

Monteverdi, Madrigals for Five Voices, Bk. 1. Roger Wagner Madrigal Singers.
Allegro alg 3020

An unaccompanied solo group sings these romantic, dramatic madrigals—21 on this LP alone and more to come. Fine balance, pitch, good sense of line and continuity, but there is a strange monotony of tempo; everything is in the same moderately slow pulse. Taken a few at a time these are superb.

Monteverdi, Salve Regina, Magnificat secundo; Verdi, Ave Maria, etc. Phila. Choral Enemble, Fleetwood. **Allegro alg 3019**

Solo ensembles and chorus both sing in our familiar florid church-choir manner; OK for the 19th century Verdi (though pitch is not good in his works here) but the earlier Monteverdi, 17th century, is reduced to just another Sunday anthem. Best steer clear unless you know M. pretty well.

Try These for Good Hi-Fi Music

[f] **Brahms, Symphony #2.** London Philharmonic, Fürtwangler. **London LL 28**

A remarkably gentle, sweet performance—welcome change after too much forced pomposity in this unpretentious symphony. Interesting note: the high end seems exactly flat, without preemphasis; it plays, distortionless, minus any roll-off and sounds fine. A good example for those who would like to hear the difference in their own equipment between a typical pre-emphasized wide-range record (take any good new LP as recommended in these columns) and fix your controls so it and this one sound alike. See for yourselves.

Dvorak, Symphony #4. Amsterdam Concertgebuow, Szell. **London LL 488**

[*h] **Dvorak, "Nature, Life and Love"—Three Overtures. (Amid Nature, Carnival,**

Othello); Notturno for Strings. Vienna State Opera Orch., Swoboda.
Concert Hall CHS 1141

Two excellent LP's of this ingratiating late-Romantic composer. The Szell 4th easily rivals Columbia's Bruno Walter version; it is played with the greatest of expression and care, recorded melodiously with good ffrr technique. (Some pre-emphasis as directly compared with the Brahms above.)

Concert Hall's 4-way Dvorak LP is an outstanding technical job. Very heavily recorded but surprisingly free from distortion — whoever cut this master did a nice job. The miking is just "right"—hits that peculiar correct balance of liveness that makes the music spring into perspective, with a wealth of fine detail work and fine sense of depth. The first and third overtures are best—each takes on a mood, the Othello being astonishingly bleak and ominous for Dvorak. Not great, but rewarding music.

Goldmark, Rustic Wedding Symphony. Vienna State Opera Orch, Swoboda.
Concert Hall CHS 1138

Funny—I suspect tapes for this and the Dvorak above were practically identical, but this comes off a bit less well technically. Lower cutting level (more music to fit in) but also a slightly duller sound. Mikes? Or — as is always possible — the composer's fault?

Arensky, Variations on a Theme of Tchaikowsky.
Grieg, Holberg Suite. Harold Byrns Chamber Orch. (Strings). **Capitol P8158**

Now, now, Capitol! After all the fanfare over FDS (Full-Dimensional Sound—see Æ, April), this makes strange listening. Same orchestra, same conductor both sides. But, apparently, an utterly different curve; the Arensky plays fine with usual slightly-less-than-NAB high roll-off, but the Grieg on the reverse seems to need flat high playback—it's dull and soggy otherwise. (Might conceivably be tape misalignment, which cuts highs; if not that, then *you* tell me.) The Arensky, by the way, is a fine piece and nicely played here. Try London's "Holberg."

Brahms, Double Concerto for Violin and Cello, op. 102.
(a) Fournier, Janigro; Vienna State Opera Orch., Scherchen **Westminster WL 5117**
(b) Milstein, Piatigorsky; Robin Hood Dell Orch., Reiner. **RCA Victor LM 1191**

Technically an interesting comparison — since the Westminster happens to be an RCA pressing. The RCA version is lacking in any significant highs over 6000 to my ear but is a big, pleasing sound and well balanced, even so. The Westminster is super-hi-fi, with gorgeous highs and bass, fine solo tone, sharp, close-up perspective (too close); would rate tops technically if it had the liveness indispensable to this Romantic music. The Robin Hood (Phila. Orch.) is bigger, far more accurate than the Vienna outfit which plays raggedly, but Reiner's cold, shiny climaxes don't move me as much as Scherchen's warm ones. Fournier's violin is weak, other solos good.

Strauss, Oboe Concerto (1945); Violin Concerto (1881). Erich Ertel, ob., S. Borries, vl., Radio Berlin Symphony, Rother.
Urania URLP 7032

Of great interest to anyone who knows the familiar Strauss — Til Eulenspiegel, Death and Transfiguration, Salome, and the rest—these works, composed sixty-four years apart make a wonderful pair. The Violin Concerto composed at 17, is like any big, old-fashioned Romantic piece, full of noise and hair-tearing; but I like it better than the Vieuxtemps and Lalo and what-not that violinists usually inflict. The oboe work, from his mid-eighties, is serene, calm, melodic, economical, modest—all of the pomposity, the cruelty, the overbearing egoism in the earlier man (however brilliant it all was) is utterly gone. This is a calm, golden evening of music without a trace of modernity yet, one senses, a final resolving for old Strauss of the entire "modern" whirlwind of development of which he was the great leader at the turn of the century, and its dynamic storm center. A moving piece. Recording good except for bad distortion in some parts. (Urania seems unduly careless in such matters.)

* **Handel, Six Organ Concertos, op. 4.** Walter Kraft; Pro Musica Orch. of Stuttgart, Reinhardt. **Vox PL 7130** (2 in box)

Handel, Six Organ Concertos, op. 7. (Same) **Vox PL 7200** (2 in box)

*a **Mozart, Thamos, King of Egypt: Incidental Music, K. 345.** Pro Musica Orch. and Chorus of Stuttgart, Reinhardt. G. Neidlinger, bass. **Vox PL 7350**

More of Vox's Stuttgart work, under Herman Adler's direction (see Buxtehude above) and all of this in the "find" category for those who like Mozart and Handel.

The organ concertos are, if you don't know them, unlike what you might expect — they are popular, simple works, as straightforward as the "Water Music" and as likeable. Gluck put it that Handel's English audiences needed "something they can beat time to, something that hits them straight on the ear-drum"—a very apt remark for today! Very nice recording, performances on a revamped and colorful baroque organ (doesn't sound churchy), a trace Germanic and deliberate but not too much.

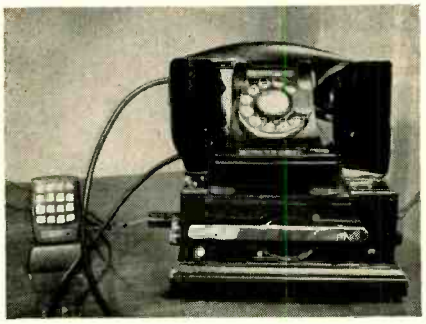
Mozart's "Thamos" is a wonderful collection of short instrumental pieces and choruses, sung here apparently by a choir of men and boys—beautifully done, too. The choruses are elaborate and on a large scale, though light as air in texture. Good scoop for Vox.

* **Handel, Utrecht Te Deum; Anthem: Let Thy Hand be Strengthened.** Solos, Orch., Chorus Danish State Radio, Wöldike. **Haydn Soc. HSL 2046**

Just in from the Haydn Society (like others, they were impeded by the recent strike) and a superb record of its type; the Te Deum is a magnificent and showy celebration piece, like the showier portions of the Messiah, the anthem a more formal work, like a three-movement concerto grosso for voices. The whole is sung in English by these Danes—faultlessly, and more naturally than plenty of our own choirs! Got to hand it to them. Top recording of the sort.

Meet the Teleloud

An audio device which has passed the development stage and on which has recently been issued patent No. 2,501,212, is the Teleloud—an accessory for use with telephones to amplify both incoming voice and outgoing reply. There is no attachment to nor any interference with the normal use of the telephone in the regular way when desired.



In operation, the Teleloud functions as base for the telephone, as shown, in the illustration of a pre-production model. To answer an incoming call, one must only press down on the bar shown on the front of the device. Raising the bar discontinues the connection. Power supply is obtained from regular a.c. lines.

Designed and patented by Fred L. Cunow, Teleloud is now in process of commercial development, and is expected to be available to users by next fall.

CABINET DESIGN

[from page 27]

An amplifier that requires more mounting space than this—even one including a separate power supply—is likely to be more powerful than is necessary for a home installation.

While amplifiers vary more in size than either of the components previously discussed, they are usually the easiest to accommodate in the cabinet because they can generally be controlled from the tuner. Since they do not usually have to be accessible from the control panel, they can be placed anywhere in the cabinet that may happen to be convenient.

Preamplifiers are becoming increasingly important as separate components and are, therefore, deserving of separate consideration. The larger types of separate pre-amps are from 10 to 12 in. long, 2 to 3 in. high, and 6 to 8 in. deep.

These types, when used, will generally supplant the tuner as the control control unit, and in consequence, their knobs must be brought out on the control panel. This constitutes no dimensioning problem since the control panel width has already been set by the tuner at a measurement wider than that required by the pre-amp. However, for the cabinet designer, the pre-amp does cause certain other unfortunate consequences. This is because of the multiplicity of controls evident by the time you have brought out from three to seven tuner controls, and from three to nine pre-amp controls.

Several of the tuner controls are, of course, duplicated on the pre-amp. This is at best a poor situation, and some of the superfluous controls may be eliminated from the tuner, leaving only the station selector and the AM-FM switch. When this is done, the one or two controls left may be awkwardly placed, which may necessitate some relocating. It would be desirable if tuner manufacturers placed the station selector in the center of the control face of the chassis.

The Loudspeaker

The speaker is the last, and perhaps the most controversial component. There is something less than a happy unanimity among the electronics people regarding speakers and speaker enclosures.

There are, apparently, three basic kinds of speaker arrangements:

1. The single or co-axial speaker mounted in either an "infinite" or a ported baffle.
2. The "Tweeter" and "Woofer" with crossover network in something falling between an "infinite" and an infinitely complicated baffle.
3. The multiple cluster, generally requiring a huge baffle.

In general, the larger the baffle the better, or to put it another way, the baffle is more likely to be too small than too large. Furthermore, it should be constructed of nothing lighter than ¾-in. plywood, which should be battened to reduce resonance, and padded inside to provide selective frequency absorption.

However, from here on out the whole

subject begins to become increasingly obscured to the point of virtual opacity. Disregarding the question of which speaker made by which manufacturer should be used, there are those who prefer the "infinite" baffle, those who still hold to the ported or reflex cabinet, others prefer the corner speaker, and yet others will have nothing less than an exponential horn, but can't agree on how best to approximate one.

The confusion over speakers and speaker enclosures is probably due to the fact that speakers are notoriously the least efficient components in any audio system, and that any device that materially improves some of the speaker problems must perforce ignore others. Discussions relating to speakers seem often to end up with the conclusion that "it depends on the individual ear." While it is refreshing to find this much recognition of the importance of human individuality among scientific minds that are otherwise prone to minimize this factor, they might be a trifle more candid if they admitted what they don't know before throwing the onus on the individual ear.

Since the engineers can only leave the matter eventually to the individual, the writer's experience has been such as to find either an "infinite" baffle that is sufficiently large for its speaker, or a simple corner cabinet adequate for residential use. You can put either a single speaker, a "Tweeter-Woofer," or a multiple cluster in either of these types of enclosures, and either one can easily be made to give a decent appearance.

Approximate cubic volumes necessary for an infinite baffle are:

8-in. Speaker	— 5½ cu. ft.
10-in. "	— 6¾ cu. ft.
12-in. "	— 8 cu. ft.
15-in. "	—10 cu. ft.

It will seldom be necessary to exceed these volumes, and often you can get away with less.

The above figures will suffice for an infinite baffle of either rectangular or triangular (corner) type. Slightly less volume is necessary for corner cabinets of the type that use the walls as sides, with the ports along the walls. These seem to depend on the size of the ports and the characteristics of the specific speakers used.

The only other considerations imposed on the cabinet designer by the equipment are few, and simple. Ventilation and accessibility for servicing are usually taken care of at the same time by leaving the back of sections housing the tuner and the amplifier open, and not crowding the components themselves. If for some reason the back has to be visible, it can be covered with perforated prestboard, perforated sheet metal, or even grill cloth, and vents may be cut in the bottom.

Practical Cabinet Designs

We may now consider some specific cabinet solutions based on the dimensions and considerations given above. There are several manufacturers who offer standardized cabinet units for housing home audio systems.

One company makes three standard models, all of which suffer from the same major drawback. The design is simple but pleasant, construction and finish are good, changer and tuner spaces are adequate, and with one exception, speaker enclosures are adequate. However, no space is provided for the amplifier unless it is put in the speaker enclosure which is most undesirable; furthermore there is no space on the control panel for a separate pre-amp.

With the exception of about two designs, most other standard models seem to have the same trouble—no amplifier or pre-amp space. The reason for this is that the mass market is not as exacting in its audio requirements as the high-fidelity fan; and the manufacturers who are in the field are after the mass market. Apparently, the number of people with exacting ears do not yet constitute a sufficiently formidable mass to appear as a profitable market to any of the major furniture or cabinet manufacturers.

Now, before proceeding to a few of the writer's own solutions, it seems desirable to preface very briefly by stating in advance that all of the designs to be shown are strictly in the modern vein. Most of them, however, could easily be executed in one of a number of period styles, and this would be desirable if it were contemplated to put the cabinets in a period room. The details that constitute the differences between Victorian, Biedemeier, Sheraton, Provincial, Chippendale, are not important here. Suffice to say for our purposes that the size and basic proportion of the cabinet must be determined by the components, and the desired period style can be approximated by the wood and finish used, as well as by the detailing of legs, mouldings, paneling, and so on.

For purposes of description, cabinet types are broken down into three general categories which seem convenient. The first is a cabinet of minimum size for housing the electrical parts only and necessitating a separate speaker enclosure. The example shown in *Fig.* 1 is of this type. It is of minimum size compatible with the maximum component dimensions given previously. Essentially it is nothing but a rectangular box on legs, opening by a lid. The setback of the front panel is made purely for reasons of appearance in order to somewhat break up the boxlike effect at minimum cost. Length and height of the enclosure are kept to even feet to keep costs to a minimum, since as soon as you go over the even foot by a fraction of an inch you're charged in wood for the next foot.

The lid opening is not particularly desirable from the design standpoint, but it simplifies construction and thus helps keep the cost down. The trouble with a lid opening is that your wife will immediately want to put a vase on top—which you will have to move every time you want to use your rig, but this inconvenience saves you money.

The material for this cabinet, as well

as the others to be described, should be solid core or veneer core ¾-in. plywood. Large unfastened areas such as the lid are better done in veneer core as it is more resistant to warpage. In no case is the use of solid lumber advised as against plywood, due to the danger of warpage and cracking induced by temperature changes, although solid stock is generally cheaper than comparable veneered ply.

A similar cabinet, *Fig. 2*, is designed with an alternate leg treatment, using a wood base instead of wrought iron. The wrought iron legs are somewhat lighter in effect.

The cabinet of *Fig.* 2 is preferred for small apartments since it provides record storage space below the equipment. This makes it necessary to reduce the over-all height of the equipment space by 2 in., but adequate space remains.

Figure 3 is an example of the second general category, namely a somewhat larger type of cabinet which includes space for the speaker as well as the other components all in one enclosure. This design is more desirable from a functional point of view, since the lid opening is done away with and replaced by two front openings—one for the changer and one for tuner and pre-amp.

Some persons will object to the inclusion of the speaker in the same cabinet with the other parts. For those who do object, an alternate form of this design would be used, dropping the speaker section out of the center and shortening the length by that amount.

The third general category is a polyglot, and includes the equipment in a multisectional multipurpose wall unit. This arrangement has many of the advantages of a built-in installation without the major disadvantage of not being movable.

The complete unit of *Fig.* 4 includes book and/or record storage and a small bar along with the audio system and a TV set. Since the complete unit is already 8 ft. long in this model, the tuner is dropped below the recommended height from floor level. This compromise was made in order to avoid adding another foot and a half of length, which would have made the whole unit bulky.

Figure 5 is another multipurpose wall unit consisting of audio system, bar, storage cabinet, desk, and shelves. With this kind of cabinet very little else in the way of cabineting is necessary in a living room and, in consequence, the rest of the space can be utilized for seating and socializing. This is desirable for those who live in apartments.

Cabinet Material

With regard to materials, as stated previously, veneered ¾-in. plywood is preferred for the cabinet itself, but legs, mouldings, and trim, must be in solid hardwood.

As to the specific veneers recommended, there are a tremendous number available, and for durability one generally is as good as another. Durability in plywood is a property of the plying construction itself, rather than of the variety of top veneer used, making the choice of surface veneer a matter of personal taste. In cost, most of the cabinet grades of veneered ply are fairly close together.

If you should select strongly grained or figured wood, one or the other of two unfortunate possibilities may occur. First, you are more likely to tire of the appearance rapidly; and second, a strongly figured wood may tend to increase the apparent size of the cabinet. Probably the most popular woods at present are the various mahoganys, oak, and birch, with walnut running not far behind these basic three.

As to construction, it is desirable that joints should be tongued and mitred—or at least mitred—and all exposed cross-sections of plywood should be veneered. If you look around the back of the cabinet at the unveneered edges, you can easily tell what kind of joint has been used. Don't accept butt joints—that is carpentry, not cabinet work, and if you're paying for cabinetry, don't take carpentry. The objection to butt joining is primarily that it has to be nailed from the outside, the nails set and the holes filled with either plastic wood or putty. Temperature and humidity changes cause the filling to start leaving a series of unattractive holes.

In general, if the construction *looks* neat, clean, and precise, it is probably good and solid, too. More shoddy jobs result from clumsy designs than from poor construction. In general, it may be said of finish that, like construction, if it *looks* good, it doubtless *is* good. A finish that is smooth, even, and silky is good—one that is lumpy and of uneven gloss either was not rubbed down enough between coats, or was not properly thinned, or not properly applied, or the surface was not properly prepared or cleaned before finishing was begun.

In conclusion—here are two cautions: don't try to stain one kind of wood to look like another kind, because the grain will not match and therefore the job will not look right; and beware of gray mahogany finishes because they usually tend to turn yellow.

AUDIO PATENTS

[*from page 4*]

improving musical resources electronically? On the other hand, maybe the change in balance with level, accidental though it may be—the design of both organ shutters and human ears is traditional and is based on necessity—is desirable, either from the absolute musical standpoint or just as a matter of "naturalness" or conditioned preference.

Anyway, how Hammond does his trick is shown in *Fig. 3*. A network, consisting principally of R_1, C_1, C_2, and R_2, is placed

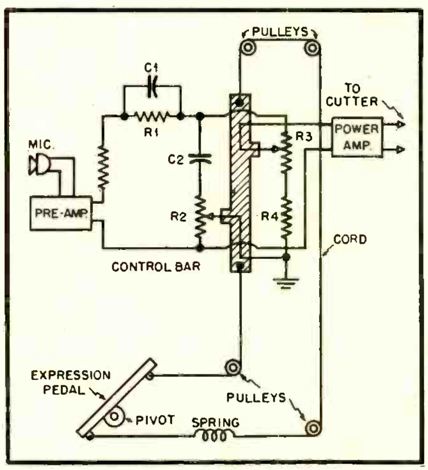


Fig. 3.

between the preamplifier and the power amplifier which feeds the disc recording head. A control bar of insulating material is pulled up and down by a cord arranged to run over suitably placed pulleys when the organist operates the expression pedal already set up to control the swell shutters.

When the top of the swell pedal is pushed and the shutters are fully open, the control bar is at its topmost position. The arm of R_2, mounted on or geared to the control bar, is at the top of R_2, grounding the bottom of C_2 and greatly attenuating the high-frequency response of the system. The response is restored, however, by R_1–C_1, a standard high-boost circuit.

As the bottom of the pedal comes down and the shutters close, the contral bar comes down, too. More and more of R_2 is inserted between C_2 and ground, removing the high-frequency shunt gradually and raising the treble response.

R_3 and R_4 are volume-control resistors, a standard potentiometer arrangement. As the bar comes down and the highs increase, the arm of R_3 comes down as well, lowering the over-all volume and keeping the average level fairly constant.

Two additional drawings in the patent show how the same thing can be done electronically. The circuits automatically emphasize highs as the volume of the input decreases. In this case, of course, the effect takes place, not only when the swell pedal is operated, but also when stronger- or weaker-voiced stops are pulled. This idea gets even more controversial, for obviously it changes the harmonic content and the voicing of the various ranks of pipes.

A copy of any U. S. patent may be obtained for 25¢ from the Commissioner of Patents, Washington 25, D. C.

Book Reviews

Electrical Measurements, by Forest K. Harris. 784 + xii pages, illustrated. New York: John Wiley & Sons, Inc., 1952. $8.00.

Measurement is the cornerstone of all science, and nowhere is this statement more true than in electricity. Mr. Harris gives us herewith a full treatise on this subject, based upon his many years as a teacher. The emphasis placed on the several sections reflects their weights relative to the whole field of electrical measuring practices.

Introducing the several systems of units used in electricity and their derivation from the mechanical counterparts, the text passes to the analysis of the several instruments used in electrical laboratory work. Their functions, relative sensitivity, and technique of handling in laboratory work are covered, as well as their limitations. Particularly complete is the discussion affecting bridges used in resistance measurement, and the many patterns these instruments can take.

Magnetic measurements, a.c. measurements involving instruments directly and in conjunction with current and voltage transformers, and power and frequency measurements all come into the discussion, as do waveform analysis and the a.c. bridge. These latter chapters will be of interest to the audio worker, as they deal specifically in the commodities in which his interest lies. The presentation is excellent, for mathematics is employed to substantiate the statements of the design and accuracy of the instruments, and a full discussion is included on the accuracy of measurements and the use of the technique of significant figures.

This is a text of specialized interest, but of significance to the laboratory worker who wishes a complete handbook on measuring in all its particulars as applied to electricity. The index is comprehensive and facilitates reference to the full coverage which the book gives to this wide field.

—*LBKeim*

Television Engineering, by Donald G. Fink. 690 + xiv pp., + 12 pp. appendix + 18 pp. index, 512 illus. New York: McGraw-Hill Book Co., Inc. $8.50.

Although this book is presented as the second edition of the well-known classic "Principles of Television Engineering," it is practically an entirely new volume. Over 90 per cent of the text is new, as are most of the illustrations. The only resemblance the present book bears to the original is the excellence of the presentation, the coherence of its contents, and the clarity of the exposition.

The text covers the basic principles of television systems, the analysis and synthesis of television images, cameras and pictures, scanning and synchronization methods, the transmission and reception of television signals, and an exceptionally excellent presentation of color fundamentals for TV engineers and a description and analysis of the various color television systems that have been proposed.

Each chapter of the book is supplemented by a very complete and lengthy bibliography covering both other books and the contemporary literature. In addition, a series of exercises are appended to each chapter. Finally, an author index and a subject index, both extensive, are included.

Television has grown to the extent that it is no longer possible to present within the confines of one volume a complete dissertation covering all facets of the science. This book, however, presents in the clear style that is characteristic of all its author's writings the fundamentals of both monochrome and color television. It is a book that should be in the library of every engineer and student concerned with television.

—HAChinn

Time Bases, by O. S. Puckle. 387 pp. New York: John Wiley & Sons, Inc., 1951. $5.00.

The first edition of this excellent volume on sweep circuits met with immediate acclaim, and now a new edition has been published containing much of the wartime-developed circuitry for generating precise time bases. One of the important additions is an entire chapter on Miller Effect sweep generators. Among the modern generators of this type are the phantastron, sanatron, and sanaphant. Each is described in detail and circuits with representative values are given in many cases.

Not only are types of sweep circuits discussed, but triggering, linearization of the trace, deflection methods, and synchronization are thoroughly covered along with circuits, oscilloscope traces, and possible changes for special application.

An appendix of over one hundred pages covers such material as cathode ray tube operation, forms of distortion of the trace, photography of the trace, electrical networks for differentiating, integrating, and computing and the generation of square waves and pulses. The author has included frequent references to contemporary literature on the subject for those seeking further information. Although comprehensive in scope and small in size, the book gives each subject thorough treatment.

—LSGoodfriend

The Recording and Reproduction of Sound, by Oliver Read, Editor. *Radio and Television News.* 800 pp. Indianapolis: Howard W. Sams & Co., Inc., 1952. $7.95.

Vastly expanded and vastly improved over the first edition, this volume will serve as a reference book on audio equipment for both novice and engineer, for it compiles in one place most of the information on this subject which has ever appeared in *Radio and Television News.*

The subjects covered are principally those which would appeal to the hobbyist, and the work commences with a discussion of sound before entering into the more technical phases of recording and reproducing it. All types of recording now in use are discussed, and the equipment used throughout the entire operation of recording and reproduction are described. The book is recommended as a study book for the novice, and as a reference book to anyone in audio work.

NEW PRODUCTS

• **Broadcast Microphone.** RCA's new Type BK-1A microphone is designed to provide broadcasters with a small, low-cost unit with good frequency response and relative freedom from the effects of wind and moisture. Suited particularly for remote broadcasts, the microphone is small, ruggedly constructed, and finished in non-

obtrusive gray for TV. The BK-1A is a pressure-type microphone in which voltage response is made nearly independent of frequency by coupling acoustic circuits to the diaphragm. Frequency response is 60 to 10,000 cps. and effective output level is −53 dbm. In most respects the BK-1A duplicates RCA's popular Model 88-A, which it replaces. However it is much more suitable for TV because of improved appearance. RCA Victor Division of Radio Corporation of America, Camden, N. J.

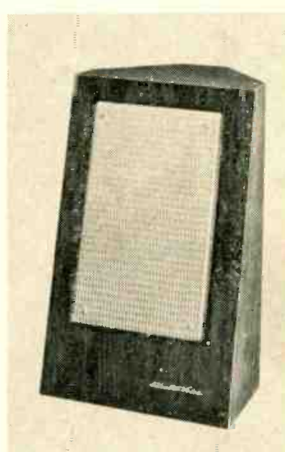
• **Tiny Tape Recorder.** Appropriately designated the "Interviewer," a new model in the Magnemite series of tape recorders carries its own dry-cell power supply, measures but 11½ × 8½ × 5½ ins. and weighs only 9¾ lbs. including bat-

teries. The unit contains a spring-wound motor which runs 15 minutes on a single winding, and may be rewound during operation. A warning light flashes approximately one minute before rewind is necessary, thus ensuring program continuity. Battery life is 100 hours. Tape speed is 1⅞ ins./sec., permitting two hours of recording on a single 5-in. reel. Frequency range is up to 3000 cps. The "Interviewer" permits headphone monitoring while recording, also contains its own playback preamplifier for feeding headphones or an external amplifier and speaker. Complete descriptive material will be mailed free on request by Amplifier Corp. of America, 398 Broadway, New York 13, N. Y.

• **Magnetic Tape Mailing Carton.** Both porfessional and amateur recordists will welcome a new carton for mailing and remailing individual rolls of recording tape now available to jobbers and dealers from Minnesota Mining and Manufacturing

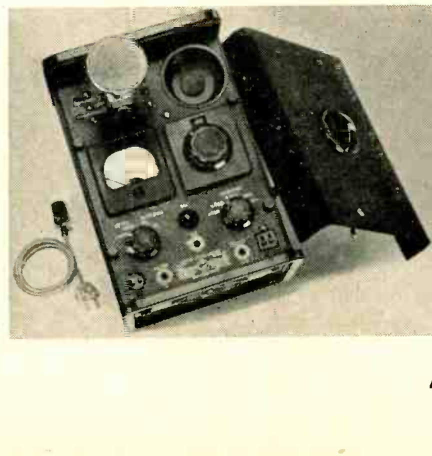
Company, 900 Fauquier St., St. Paul 6, Minn. Made of corrugated fibreboard, the carton provides adequate protection with minimum weight, is inexpensive, and reusable. Available for 4-, 5-, 7-, and 10½-in. reels.

• **Folded-Horn Corner Enclosure for 8-Inch Speakers.** Bass response as low as 35 cps is stressed in Electro-Voice's announcement of the "Baronet," the newest and smallest of the company's corner speaker enclosures manufactured under Klipsch license. Designed for 8-in. speakers, the Baronet is remarkably compact, measuring only 23½ in. high, 14½ in. wide, 10½ in. deep at the top and 11 in. deep at the bottom. In operation the en-



closure functions as the throat of a horn whose final extension is the walls of the room in which it is situated. High frequencies are direct-front-radiated. Total internal displacement of the unit is approximately 1½ cubic ft. Available from jobbers and dealers in hand-rubbed mahogany or blonde finish. Electro-Voice, Inc., Buchanan, Mich.

• **Sound Level Meter.** Hardly any sound-level measurement problem can be conceived which cannot be solved readily with the new General Radio Type 1551-A Sound Level Meter. Designed around new tubes, components, and miniaturization techniques, the new instrument weighs only 11 lbs., less than half the weight of

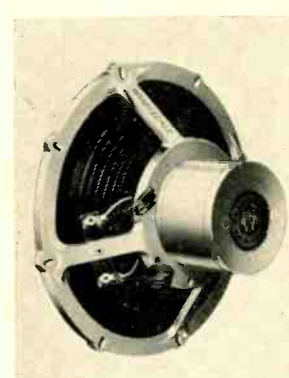


its predecessor, also occupies less than half the older instrument's volume. Overall frequency response of the two-stage preamplifier and three-stage main amplifier in the 1551-A is 20 to 20,000 cps. All characteristics of the instrument conform to ASA specifications, and direct measurement of sound pressure levels can be made over a range of 24 to 140 db, a power range of 400 billion to 1. Power supply is afforded by self-contained batteries. The 1551-A is equipped with a diaphragm-type Rochelle-salt microphone. General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.

• **New V-M Record Changer.** Improved styling is featured in the new V-M line of record changers which will be introduced publicly for the first time at the coming Radio Parts Show in Chicago.

Mechanical features of the previous V-M line, including the "Siesta switch" which shuts off the entire music system after the last record is finished, have been retained. Although the new models represent considerable improvement over previous ones, prices remain unchanged. V-M Corporation, Benton Harbor, Mich.

• **Wharfedale Tweeter.** Newest of the speakers to be designed by G. A. Briggs, noted British audio authority, is the Wharfedale Super 5, a 5-in. high-frequency unit for extending the frequency range of existing two-way speaker systems. Constructional features include a Bakelized cone and an aluminum voice coil. Flux density is 13,000 lines. Effective frequency range of the Super 5 is 3000 to 20,000 cps. Typical of other Wharfedale speakers, the unit employs cloth suspen-

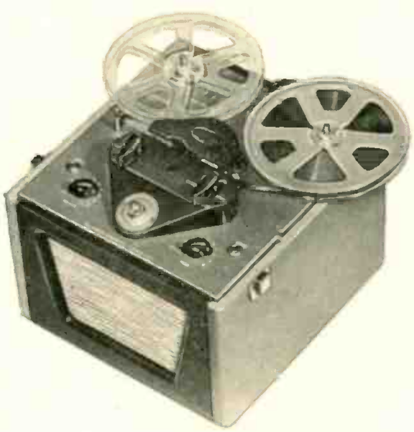


sion of the cone. The Super 5 is supplied mounted on an 8-by-8 in. plywood board with 3½-in.-diameter aperture, which is the effective cone diameter. May be used with two-speaker systems employing 1000-cycle crossover merely by connecting in parallel with the present treble unit and by inserting a 0.5-μf. capacitor in series with the voice coil of the Super 5. British Industries Corporation, 164 Duane St., New York 13, N. Y.

• **Variable-Capacitance FM Pickup.** Operating on a unique variable-capacitance principle, the new Weathers pickup is capable of tracking at a stylus pressure of only one gram when mounted in a well-designed transcription arm. Record wear is virtually non-existent. Frequency range is 20 to 20,000 cps. In operation the pickup drives an external oscillator using a 6AT6

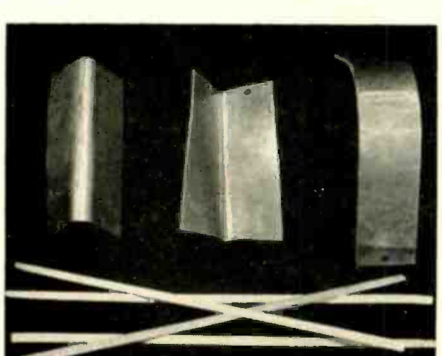
tube. Oscillator output is 0.5 volt at high impedance — can be fed into crystal or tuner input of any high-quality amplifier. Power required is 6.3 volts a.c. at 0.3 amp and 250 volts d.c. at 2 ma, which may be obtained from amplifier or from Weathers power supply which is available as an accessory. Weathers Industries, West Collingswood, N. J.

• **Two-Speed Portable Tape Player.** Excellent audio characteristics at low cost are found in the new Pentron PB-A2 twin-track tape player, a portable unit designed for reproduction from tape where recording facilities are not required. Operating speeds are 3¾ and 7½ ins./sec. Frequency response at the higher speed is 50 to 8000 cps. Flutter is less than 0.5 per cent.



Power output to built-in 6-in. speaker is 5 watts. Output jacks permit feeding external speaker, headphones, or external amplifier. Extremely portable, the PB-A2 measures only 11⅝ x 12¼ x 9¾ ins. and weighs but 22 lbs. Pentron Corporation, 221 E. Cullerton St., Chicago 16, Ill.

• **New Aluminum Solder.** Brazinal, a new compound which serves to join aluminum and its alloys, has just been introduced by A. E. Ulmann & Associates, Ltd., 30–81 21st Street, Long Island City 2, N. Y. Used in a manner similar to brazing rod, Brazinal is simply rubbed along a joint after the metal is heated by a torch or gas flame. For small sections, sufficient heat may be obtained from small alcohol torches, and an ordinary gasoline blow torch will provide adequate heat for larger parts. No flux is required—and 1/16-in. aluminum sheets will tear before breaking apart at the joint. Brazinal is supplied in convenient lengths and sizes suitable to the work on which it is to be used.



FEEDBACK

[*from page 21*]

sary for oscillation are not so effective as in the middle range.

The net result of these conditions, found in a number of single speakers and speaker systems (including crossover networks) investigated, is that Z_m tends to become so small at the middle-range critical frequency—in the order of 1.5 ohms as against an R_{vc} of 8.5 ohms—that a close approach to perfect damping causes high instability, so much so that in the amplifier used—far above average in every respect—ringing followed by oscillation, took place inevitably at the frequency at which measured and calculated Z_m was lowest. Thus, Clements' implied remedy—limitation of amplifier bandwidth to the range where Z_m is high—would give an amplifier without a middle audio range and does not appear to be useful. The writer did find it possible to cancel out all of R_{vc} with very careful adjustment, but the high regulation that went along with this made the adjustment extremely critical, with much obvious "ringing" and a strong tendency to oscillate whenever the experimenter took a deep breath.

The high negative regulation (16 to 17 db) was, of course, due to the small remaining Z_m at the critical frequency Clements' statement that regulation is not excessive at perfect damping does not prove out to be entirely accurate, at least at the critical frequency, which is the important one to consider in practice. Regulation will, of course, be much lower at other frequencies. Being dependent on the ratio of voice-coil resistance to Z_m, it will be satisfactorily low at the high frequencies where Z_m is high, and also at resonance.

While Z_m must be considered, as was pointed out, in practice it appears to become so low at such an important frequency when regulation is perfect that it may almost be removed from the formula

$$\frac{e}{E} = \frac{Z_m + R_{vc}}{Z_m}.$$

Thus, while the writer's original formula was technically inaccurate, in practice it is still a governing factor in the achievement of high damping.

Is All This Desirable?

Clements very properly raises the question of whether high negative amplifier output impedance is a good thing, and this writer agrees that it is certainly a mixed blessing. It obviously increases instability, though much of this can be removed by high negative feedback of the conventional type.

The most obvious result, it is agreed, is loss of low-frequency response. As has been shown (see also below), the effect of perfect cancellation of R_{vc} is to place a constant voltage across Z_m at all frequencies. Since Z_m rises at low frequencies above the mid-frequency value, Z_m—the working part of the voice-coil impedance—takes less power and less acoustic power is radiated. Z_m is also lower above the mid-frequency value, but air coupling is better, at least to the point at which the high-frequency horn-type speaker takes over in a good dual-speaker system. The solution is either to increase negative output impedance only to the point where bass remains satisfactory or to add more negative impedance for better damping and add bass equalization in the amplifier or preamplifier circuits. The latter is difficult to do accurately for a number of reasons. Thus, this writer, even though his approach has differed somewhat from that of Mr. Clements, comes to the same practical conclusion—adjust for the best sound!

Some Interesting Data

In the course of investigating this subject, the writer made a large number of measurements. The most interesting are summarized here in text and graphs.

Figure 1 includes two curves which show the results of actual measurements made by the writer on the Childs amplifier and on a Jim Lansing speaker system consisting of two bass and one high-frequency horn speakers with a 1,000-cps crossover network, in a completely enclosed baffle with about 15 cubic feet of internal air space.

Determination of the motional impedance of the speaker system was made by two methods, both involving actual measurement of the total impedance and subtraction from that figure of R_{vc}, measured with a resistance bridge and amounting to 8.5 ohms. The first method employed a thermocouple-type ammeter in series with the speaker and a voltmeter across it. The second method involved simply placing the speaker system input across a standard a.c. resistance bridge. The results of the two methods agreed very closely, but at very low values of Z_m relatively small measurement errors cause large percentage errors in Z_m because of the subtraction required. It is to be noted that the general shape of the Z_m curve agrees with that in the cited reference book. This curve confirms the previous statement that Z_m rises at frequency extremes and that it reaches an extreme low point at the frequency at which oscillation is always observed to begin. Other speakers measured—both two-speaker systems and single speakers—agreed with this curve in general, though the precise frequencies at which maximum and minimum Z_m occurred were naturally somewhat at variance.

The regulation curve of *Fig.* 1 was made by measuring output voltage of the amplifier with and without the speaker load connected. It is to be noted that when a constant-resistance load was substituted for the speaker. the regulation was constant from 20 to 125.000 cps. As may be expected, the curve shows that regulation at all frequencies is approximately inversely proportional to Z_m, and that it is highest at the critical frequency of 200 cps, giving the most unstable condition at that point. Incidentally, the measured regulation agreed extremely closely wtih that calculated according to Clements' Eq. (1).

To determine how the power consumed in Z_m is affected by the value of Z_m (which, as shown in *Fig.* 1, varies with frequency) with various values of negative amplifier output resistance, calculations were made resulting in the curves of *Fig. 2*.

When R_a is equal to R_{vc} (perfect damping) the voltage across Z_m is constant for all values of Z_m. The power in Z_m is therefore inversely proportional to Z_m. The topmost curve of *Fig. 2* was made on this basis, assuming 10 volts across Z_m. Note that the power in Z_m falls off as Z_m becomes larger, equivalent to the frequency becoming lower.

When R_a is reduced to a value which does not entirely cancel out R_{vc}, the power-Z_m curve changes, not only in values but in general shape. As Z_m rises, so does the power (the voltage across Z_m no longer, of course, remaining constant, since there is now some positive resistance in series with the generator). It then drops, as is shown by the center curve of *Fig.* 2. Incidentally, the value of -6.5 ohms for R_a was chosen for this illustration by a mathematical method whose object was to choose a value for which the variation in power in Z_m would be minimum for a range of Z_m values. The curve shown for -6.5 ohms is optimum, a flatter curve not being possible in the range between 1 and 4 ohms. The derivation of the method is somewhat lengthy and space does not permit its exposition.

The curve for zero amplifier output impedance is a complete reversal of that for perfect damping. Notice that here the power in Z_m rises as Z_m rises. This, incidentally, is the condition—speaker terminal voltage held constant—under which speakers are ordinarily measured for acoustic response.

The writer will not venture an opinion as to what effect these power-Z_m (actually they are power-frequency) curves have on actual acoustic response. How much of the power in Z_m is useful in pushing air and how much is consumed in overcoming mechanical impedances at various frequencies is a matter for conjecture and differs with different speakers. It is only possible to make the obvious statement that the performance of the speaker as far as the ear is concerned certainly could not be identical under all three conditions shown in *Fig. 2.*

TAPE EDITING

[*from page 16*]

sounds encountered in his work and to his hearing, the time is appreciably shorter. When material is edited so that the sensation of persistence is used, as an editing device, it has been found that persistence cannot be depended upon for much longer than three or four hundredths of a second without the cessation of sound being obvious to the ear. Irwin Pollack, in *J. Acous. Soc. Am.* for November, 1951, estimates the duration of persistence at about .055 seconds for white noise. This estimate is close to agreement with the writer's experience in editing tape. Of course no claim is made as to the persistence of sensation at very high levels of sound. When the sound level is so high that it is shocking, the hearing becomes subnormal for shorter or longer periods of time, depending upon the degree of shock. This cannot be regarded as persistence, but must be regarded as deterioration of the hearing. In the normal run of audio, we do not encounter this type of shock-deafness.

It is not clear, from a study of hearing theory, whether hearing persists in the nervous system to the brain or in the brain itself. Hearing persistence appears to vary somewhat with frequency. There seems to be more at medium frequencies than at either low or high frequencies, which may be ascribed to the variation of the ear's sensitivity.

There is a sound which is heard occasionally in editing tape that appears to be due partially to the excitation of transient vibrations in the ear and partially to the phenomenon of persistence of hearing. If two words are placed so closely together in editing that no natural interval is present between them, we sometimes hear a third sound. This sound is something added, a product of persistence plus *new recognition.* It can be demonstrated that this third sound is not on the tape but is, as far as can be determined, due to the overlapping of the persistence of one sound and recognition of the beginning of the second sound. This third sound can always be eliminated by inserting quiet tape, from the same background, between the two sounds, as in *Fig.* 4.

Persistence is a fact of hearing. Whether it is due to the excitation-time of the nervous system or to a function of the brain need not concern us too much. You may make use of persistence in creating the illusion of a blend from applause or laughter into voice, as in *Fig.* 5. The time elapsing between the persistence-exciting sound and the following sound should not exceed one-thirtieth of a second—one half inch of tape at 15 in./sec., measured on *either edge* and should be less if in any particular case the result sounds abnormal in any way. Where such a persistence-blend is made following laughter, the voice immediately after must be in the same mood. The impression a listener gets should be completely natural or the job is not right. The factors that make up the show must agree, the parts must fit together perfectly, or the illusion is destroyed.

Background Matching

Probably the greatest single problem in tape editing is the matching of background sound. The effect of persistence blending is nullified unless the same background is present to almost the same degree after the applause or laughter as before it. The transition from an audience reaction to a *dead* voice is a shocking experience for a listener. Unless it is intended to be such, there is one editing device that can be used to alleviate this condition. That is to insert enough low-level noise after the reaction sound so that it might be possible for the voice coming up to *be dead*. Of course, re-recording to add reverberation and some filtering could be used here to good advantage. But where it is impossible to re-record properly, the device just mentioned will help to keep the illusion intact.

In putting together two sequences, where background sound does not exactly match, anything that distracts the mind of the listener from his memory of the background sound and shifts it to some other sound helps to obtain a smoother transition. The effect desired here for the listener is the loss of immediate memory of what preceded in background. Any slight disturbance of short duration, a cough, a single laugh, or what not, will produce the desired effect.

Fig. 3. When two sounds are edited too "tightly," a third sound can sometimes be heard at the splice.

Fig. 4. When a minimum of 3/8 in. of background noise (preferably from preceding tape segment) is spliced between the two segments in Fig. 3, the unwanted third sound disappears.

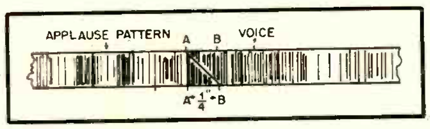


Fig. 5. Applause "persistence-blended" to voice. Note that applause should be cut immediately after loud clap, preferably when background sound is somewhere near voice background. Voice should be cut very tight, practically in the sound. At the speed of 15 in./sec., the tape between A and B is equal to 1/60 sec. The persistence of hearing excited by the last clap of applause will, however, sound as though it is in back of the voice for at least twice that time if the edit has been performed correctly.

The writer has often been so wrapped up in editing to similar backgrounds that he has occasionally paid insufficient attention to the sense of what he was editing. Strange to say, the effect of a discontinuity in sense is far less disconcerting than a sudden change in background. The mind of the listener can conceive of the fallibility of a politician making a speech, or of an actor in a drama, but he reacts with a shock when the background shifts without any reason whatsoever. Background sound change must be avoided by any of the means pointed out or by re-recording.

There is another peculiar effect which occurs when background sound is dubbed under a dead voice to match the background sound under the rest of the edited sequence. When a voice is backed up by added background noise, it appears to be higher in pitch than without the background sound. This manifestation of masking has been reported in the literature on the theory of hearing. The masking of sounds, however, is another aspect of editing, which necessarily entails the use of re-recording techniques. One cannot "unmask" a recorded sound; one can only mask another sound to match the first if the illusion of continuity of the edited sound is not to be destroyed.

There are many other idiosyncracies of hearing, but none more important to the tape editor or more easily used than those herein outlined. A continuing study of hearing is therefore indicated for the tape-editor who would perform expert work in the minimum of time.

BUDGET NEWS

[*from page 24*]

restricted to any one wood or metal. Steel, wrought iron, brass — even that cheap (though solid) curtain rod available at any hardware store—might be used.

Steel rod, actually, might be the best in a unit larger than two shelves. We've seen similar displays of this scaffolding arrangement and that was the metal used.

Source of Design

The Italians may have been the first to use such mounting materials. A recent international exposition of modern architecture held in Milan, Italy, showed one room completely furnished with this scaffolding. The rod framework reached from floor to ceiling, even crossed the ceiling at key points for better bracing of the structure. The room lighting was an integral part of the entire form, while simple panels were suspended from the upper reaches of the scaffolding, heightening the illusion of a series of display rooms. The metal parts of the structure were black-painted steel, the shelving was of glass. But the most striking feature of the entire display was its subject. Here was an exhibition of rare, old books—priceless records of man's efforts to write down his thoughts on this matter of design. Yet the scheme of metal scaffolding and glass was as vital and dynamic as the subject of the exhibition itself.

This all seems well removed from our description of the unit pictured, but we do want to point out the practicability of these materials in this sound system. Naturally, not everyone caters to ideas similar or complimentary to those here. But sharing this architect's likes and tastes, we are quite pleased to present this as one of the most interesting designs of its kind. Many factors are involved in designing cabinetry in keeping wth a five-hundred-dollar sound system. Cost is the first and most important. A compromise might mean fir plywood rather than a solid, bleached mahogany. Yet the design is attractive, even though it is inexpensive.

The second consideration in system housing is its size, with possibly an allowance for increase in the number of system components—possibly a tape recorder. Too, there is the matter of record storage and that, to us, is often a headache. Most audio fans would like the records stored in the same cabinet as the system — add space, add cabinetry expense. But with this modern combination of wood and metal, only a few more rods, connectors, and planks are needed as the system expands or the record collection increases. Notice that the unit can be added to in any direction, so wall-length shelving is no problem and certainly no great expense. If the shelves are designed to a proper width, any pieces of sound equipment—even television sets—can be mounted within them.

The next factor to be considered in this newest design is the type of shelving—wood or glass. If you live out of the larger cities, look for a small lumber mill. Woods indigenous to your own part of the country shouldn't be too expensive. One lumber mill in an adjoining state will sell us any wood in the area, custom-cut to any length or thickness, for twenty cents a foot. That's quite cheap but the requirements are for simple planks. Finishing should be the least of your problems; pay three or four dollars to have the wood finish-sanded, then lay on the shellac or varnish. Glass, also, might be used, although it is more costly than wood. Try local plate glass firms. One of them might be willing to cut up odd chunks of broken show windows for a nominal amount.

Finally, the actual mounting of the audio equipment within this modern furniture form must be considered. In this unit, there are several holes—one for the tuner dial, three for the tuner knobs, five for the remote amplifier's controls, and the large one for the changer. A brace and bit, a ninety-five cent saw, and the manufacturer's templates are the only items needed to complete the installation. (An extremely small size of type should have been used for that last sentence, because the suggestion will save you the cost of custom-building and designing services.)

This has been an outline of some of the factors to be considered preparatory to *any* sound-system design or the building of any system cabinetry. Though the subject system may not satisfy your aesthetic needs, it points out graphically how the basic elements of good design, properly applied, can satisfy budget needs as well as personal tastes.

HUM NEUTRALIZATION

[*from page 22*]

work is the sum of the currents which would flow if each generator were considered separately, all other generators being replaced at the time by impedances equal to their respective internal impedances. In *Fig. 2*, the voltage e_1 is the noise voltage introduced by the power supply. The voltage ke_1 is the voltage introduced by the phase-shift circuit. Since the internal impedances of the generators e_1 and $-ke_1$ are negligible compared to the constants of the remainder of the circuit, then considering generators e_1 and $-ke_1$ separately,

$$i_1 = \frac{e_1}{\sqrt{(R_L + R_g)^2 + X_c^2}};$$

$$i_2 = \frac{-ke_1}{\sqrt{(R_L + R_g)^2 + X_c^2}}$$

If i is the resultant current, then

$$i = i_1 - i_2 = \frac{e_1 + ke_1}{\sqrt{(R_L + R_g)^2 + X_c^2}}$$

$$= \frac{e_1\,(1 + k)}{\sqrt{(R_L + R_g)^2 + X_c^2}}$$

In order that the voltage across the grid of the tube be zero, then,

$$e_1 - i_1\sqrt{R_L^2 + X_c^2} = -ke_1 + iR_g = 0$$

Substituting for i in the portion of the equation to the right, then

$$-ke_1 + iR_g = -ke_1 + \frac{e_1\,(1+k)\,R_g}{\sqrt{(R_L+R_g)^2 + X_c^2}} = 0$$

$$e_1\left[\frac{(1+k)\,R_g}{\sqrt{(R_L+R_g)^2+X_c^2}} - k\right] = 0.$$

If e_1 is unity and $X_c \ll R_L$ or R_g, then

$$\frac{(1+k)\,R_g}{R_L+R_g} - k = 0 \text{ or}$$

$$(1+k)\,R_g - k\,(R_L+R_g) = 0$$

$$(1+k)\,R_g - kR_L - kR_g = 0$$

$$R_g\,(1+k-k) = kR_L$$

$$\text{Therefore } R_g = kR_L$$

However, it is to be noted that the voltage $(e_1 - iR_L)$ produces a current through the dynamic plate resistance of the tube. If X_c is small, the voltage $(e_1 - iR_L)$ is essentially equal to the voltage e_t across the grid circuit of the vacuum tube. Consequently, the hum or noise current through the tube can usually be neglected, especially when pentodes are used. If a capacitance having a value kX_c is introduced in series with grid resistor R_g and shunted by a high resistor, then the effect of the capacitance X_c can be eliminated and theoretically zero noise voltage applied to the grid of the succeeding tube. Other capacitance balancing methods are possible.

The circuit to be analyzed is illustrated in *Fig.* 3, while the equivalent circuit is shown in *Fig.* 4. The power supply capacitance is normally very large and can be neglected. The same applies to the blocking capacitance C_s. The noise voltage E can be considered as a constant-voltage source. In the equivalent circuit, R_p and R_s are resistances in the primary and secondary circuits.

Transformer Equivalent

The response characteristics of the audio transformer T_1 can be analyzed with the aid of its equivalent circuit. Since the core-losses can be neglected, the equivalent circuit of the transformer with the secondary parameters referred to the primary circuit is as follows:

$$L_{eq} = L_1 + \frac{L_2}{n^2}.$$

$$R_{eq} = \frac{R_s}{n^2}$$

$$n = \frac{n_s}{n_p}.$$

$$C_{eq} = n^2\left[C_s + \frac{(n \mp 1)}{n}C_{ps}\right]$$

In the equivalent circuit, *Fig.* 5, L_m is the primary magnetizing inductance and R_{eq} is the secondary winding resistance referred to the primary. R_g is the external circuit resistance, which becomes R_g/n^2 when referred to the primary.

In such an equivalent circuit there are two essentially distinct frequencies of resonance as follows:

(a) Low-frequency parallel resonance between L_m and C_{eq}.

(b) High-frequency series resonance between L_{eq} and C_{eq}. The ratio of L_m to L_{eq} in ordinary interstage transformers is usually from 100 to 1000. Consequently, for the range of frequencies of interest, it is necessary to consider only the low-frequency parallel resonance. The magnitude of L_m is usually about 100 henrys or more.

For good low-frequency response, it is the practice to make the magnetizing inductance L_m large and the total resistance in the primary circuit small. These considerations are consistent with

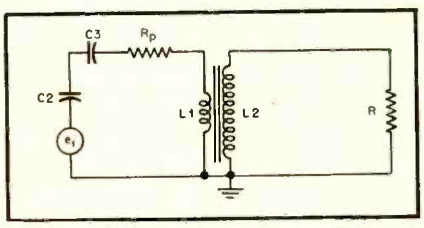


Fig. 4. Equivalent circuit of phase correcting portion of Fig. 3.

others which may be incompatible at frequencies around 5000 cps, where the high-frequency series resonance becomes an important consideration. The low-frequency parallel resonance characteristic is utilized to extend the essentially constant-voltage gain into the low-frequency region. For high-quality transformers used for speech and music, the low-frequency resonance may be at 200 cps or less.

Below parallel resonance the transformer secondary voltage leads the primary voltage. This phase shift becomes more serious, of course, as the frequency becomes less. It was found possible to adjust the parallel resonance of a Thordarson T-57A36 transformer to 120 cps by shunting the transformer secondary with a small capacitor of less than 200 $\mu\mu$f. Such a capacitor essentially will not affect the transformer output response appreciably below 1000 cps. This particular transformer has a secondary to primary turns ratio of three. The fundamental frequency component of a single phase, full-wave rectifier is 120 cps. For the range of frequencies under consideration, the practical maximum for the turns ratio in transformer design can be substantially larger than the usual maximum of three employed in high-quality audio transformers.

At frequencies higher than the condition of low-frequency parallel resonance, the phase shift is more nearly uniform and may deviate only a small value from zero degrees for a substantial range. As a result the higher-frequency harmonics always present in the rectifier output also can be reduced.

From the transformer equivalent circuit expressions can be obtained for the low-frequency gain and phase shift. In the low frequency region the effects of the leakage reactance and the equivalent capacitance C_{eq} are negligible. Then, the expression for gain is,

$$G_{low} = \frac{R_g}{\sqrt{\frac{R_s^2}{n^2 \omega^2 L_m^2} + \left[\frac{R_p + R_s}{n^2}\right]^2}}$$

Where $R_s = R_g + R$, the total resistance in the secondary circuit. The corresponding expression for the phase shift θ is,

$$\theta = \tan^{-1} \frac{R_p}{\omega L_m}$$

From these expressions it is obvious that the voltage gain approaches a nearly

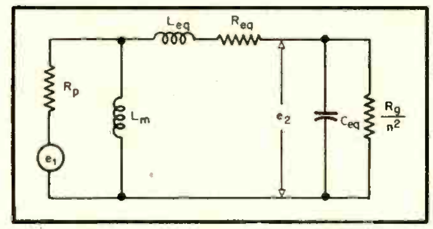


Fig. 5. Equivalent circuit of transformer at frequencies of interest.

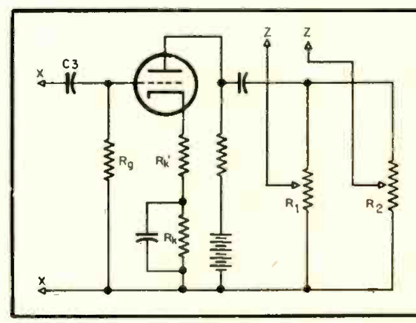


Fig. 6. Alternate use of tube instead of transformer to provide necessary phase reversal.

constant value as a limit and the phase shift becomes negligible as the frequency is increased from a low value. Beyond this region in the middle range of frequencies, the gain is nearly constant, the phase shift is small, and the output voltage lags the input voltage. As the frequency is further increased, the phase shift slowly increases and the output lags still more.

Application

Since it is possible to obtain a voltage by this means which is essentially equivalent to the hum and noise voltages arising in the power supply but reversed in phase by 180 deg., it is seen that the application of this voltage at an appropriate point in the circuit of the following stage can be used to cancel out the hum and noises from this source.

The same result may be obtained by using a single stage of amplification, as shown in *Fig.* 5, to provide the phase reversal, taking the correcting voltage from two potentiometers in the output circuit, as shown by R_1 and R_2. The choice of the values for the two potentiometers will depend somewhat on the circuit constants such as the tube employed for the phase reversal, the operating voltages, and the load resistor.

POSITIVE FEEDBACK

[*from page 20*]

cuit will be oscillatory. Here we must observe that just as surely as two and two equals four, so does two minus two equal zero. A positive resistance plus a quantitatively equal negative resistance equals zero resistance and may be so considered in circuit computations. Then we have an ideal generator facing a zero resistance.

But just a few paragraphs earlier Childs has cited an ideal generator facing a zero resistance as a case of perfect "dynamic braking." Thus he has used the same criterion for oscillation that he used for perfect damping. There's no use inquiring which use is correct, for in a strict sense both are wrong. With regard to damping, it depends on the configuration of the circuit. A series-resonant circuit is perfectly damped when driven through an infinite-resistance (i.e. constant-current) source. A parallel-resonant circuit is perfectly damped when driven from a zero-impedance (constant-voltage) source.[1] The

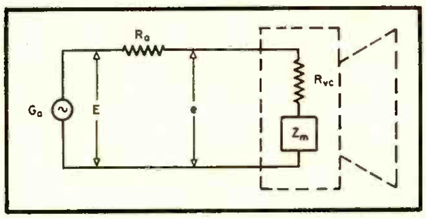


Fig. D. Correct representation of an equivalent generator driving a loudspeaker load.

motional impedance of a loudspeaker is roughly a parallel-resonant circuit on the electrical side.[2]

Oscillation, too, depends on circuit configuration. Oscillation necessarily involves the movement of energy between at least two storage elements. The energy must move back-and-forth, without diminution. But storage, in an electrical circuit means reactive elements (capacitor, inductance). The circuit of *Fig.* C, as drawn, will not oscillate at *any* value of the negative resistance. With R_a equal to the minus of R_{vc} the current is, of course, infinite. Here we have an interesting mathematical anomaly. The only energy coming into the circuit is through R_a and the only energy leaving the circuit is through R_{vc}. At this point one begins to suspect that the diagram does not represent the amplifier-speaker situation at all. Surely it takes *some* energy to make a noise. Let us be perfectly clear on this point. The energy that turns into sound is not and cannot be the same energy that turns into heat in the voice-coil. The trouble with *Fig.*

[1] Vannevar Bush, *Operational Circuit Analysis.* New York: Wiley, 4th. ed., Chap. IV.

[2] Keith Henney, *Radio Engineering Handbook.* New York: McGraw-Hill, 3rd. ed., p. 906.

C is that it lacks a resistance to represent the point where energy leaves the circuit as sound.

What Childs has done is to disregard the motional impedance. Since this cannot be justified, let us put it back in as in *Fig.* D and see what happens to his Eqs. 1 and 2:

$$\frac{e}{E}=\frac{Z_m+R_{vc}}{Z_m+R_{vc}+R_a} \qquad (1)$$

$$\frac{e}{E}=\frac{Z_m+R_{vc}}{Z_m} \qquad (2)$$

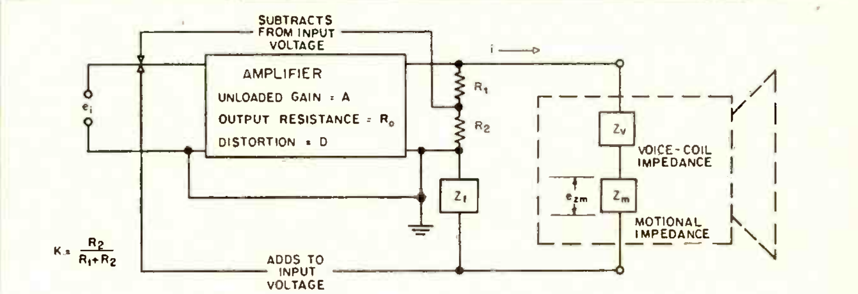
Where $R_a=-R_{vc}$

One loudspeaker, designed to drive a horn, is rated at 16 ohms and has a voice-coil resistance of only 4 ohms. This means that properly air-loaded and at the rated frequency the motional impedance should be 12 ohms. It is probably actually closer to 8 ohms, but still a hefty item to leave out of one's calculations. Any high-efficiency 16-ohm speaker will have several ohms of motional impedance. Substituting typical values in Eq. (2), one can see that at a condition of perfect damping no excessive negative output regulation is required. It follows that the graph Childs gives as his *Fig.* 4 and the instructions for using it are without validity. Aside from the considerations above one would suspect this anyway, as Childs' method treats all speakers with a given voice-coil resistance alike, even though their effectiveness as energy sinks may vary considerably.

Performance Proofs

After all the talking is through, the proof of the pudding still remains in the eating. Suppose we measure the negative output resistance of an amplifier by the method explained by Childs and illustrated in his *Fig.* 7. Suppose we set that negative resistance at, say, 10 ohms. Then, according to Childs, if we connect the amplifier to a speaker having a voice-coil resistance of exactly 10 ohms, the combination should oscillate. The writer has on hand four different amplifiers that will pass this test *without* oscillation. In fact, with a good speaker, each of them can be set from 10 to 30 per cent *beyond* the critical point (that is to a negative resistance exceeding the voice-coil resistance by that amount) before oscillation starts.

Why didn't Childs make similar findings? Paradoxically enough, it was probably because the Childs amplifier is *too good*. It apparently has excellent bandwidth. Meanwhile the feedback connection of the high-damping circuit is direct-coupled low-impedance and could not be expected to impair that performance. The probable result is that when Childs set his amplifier to a given negative impedance, it maintained that negative impedance out to frequency extremes at which the motional impedance fell to nearly zero. At these frequencies the voice-call resistance is the only appreciable positive resistance remaining in the speaker load and if it is exceeded by the negative resistance of the amplifier, oscillation may result. The needed reactances for oscillation are furnished by: 1) the voice-coil inductance (if not balanced out by an inductance in the positive feedback circuit); 2) vestigial reactances in the motional impedance; 3) apparent reactance of the amplifier output caused by phase-shift; and 4) distributed parameters and electrical lines. These reactances combine in vari-



DIAPHRAGM VELOCITY IS PROPORTIONAL TO: $e_{zm} = iZ_m = \dfrac{Ae_iZ_m}{Z_m(1+AK)+Z_v(1+AK)+R_o-Z_f(A-1-AK)}$ (1)

FOR PERFECT DAMPING MAKE: $Z_f=\dfrac{Z_v(1+AK)+R_o}{A-1-AK}$ (2)

AT VALUE OF Z_f GIVEN BY (2), $e_{zm}=\dfrac{Ae_i}{1+AK}$ (3)

OUTPUT IMPEDANCE LOOKING TOWARD AMPLIFIER FROM SPEAKER TERMINALS: $R_o'=\dfrac{R_o-Z_f(A-1-AK)}{1+AK}$ (4)

AT VALUE OF Z_f GIVEN BY (2), $R_o'=-Z_v$ (5)

DISTORTION OR GAIN INSTABILITY: $D'=\dfrac{Z_m+Z_v+R_o+Z_f}{Z_m(1+AK)+Z_v(1+AK)+R_o-Z_f(A-1-AK)}$ (6)

AT VALUE OF Z_f GIVEN BY (2), $D'=\dfrac{D}{1+AK}\cdot\dfrac{Z_m+Z_v+R_o+Z_f}{Z_m}$ (7)

Fig. E. Combined positive and negative feedback. Formulas given here are applicable to Fig. A without change. Two other variations of the basic circuit are possible and have slightly different circuit equations.

ous ways to make one or more series-resonant circuits.

These considerations are no cause for concern within the normal audio range, where the resistive part of the motional impedance remains high. All that is necessary to ensure stability at and beyond the point of perfect damping is to ensure that the performance of the amplifier as a negative impedance does not exceed the performance of the speaker; in other words to restrict the frequency range of the amplifier or positive feedback circuit to within the frequency range of the loudspeaker. This need cause no raised eyebrows. It is analogous to what many good designers do when they retrict the bandwidth of an amplifier to within that of the output transformer to prevent the negative feedback from becoming positive feedback at frequency extremes.[3]

The equations of *Fig.* E are very instructive. Eq. (3) shows that at the setting for perfect damping the voice-coil velocity will be exactly proportional to the input voltage. This will hold regardless of non-linearities in the suspension system, provided the flux density is constant throughout the gap. As far as the voltage across the motional impedance is concerned, this is a "no-error" condition and, as Childs says, no error correction can be had unless an error exists. But what Childs has completely overlooked is the fact that while the *voltage* may have no error, the *current* may have plenty, which is registered as a drop across Z_f and fed back. This can be shown by dividing Eq. (3) by Z_m to obtain the current and by using for Z_m its complex parallel-component values.

The writer is indebted to Childs for pointing out that a square wave across the speaker terminals does not represent the setting for perfect damping. As Childs correctly states, it is impossible to deduce anything from the amplitude of the transient wiggles unless the negative impedance of the amplifier output is known. Nor, as has been shown here, can it be assumed that the edge of oscillation represents the ultimate in damping. Circuit users who have no facilities for measuring a.c. resistance will just have to adjust for best sound.

This, in view of the bass response situation, may be the best method anyway. As explained in the original article, bass loss with a direct-radiator speaker may run as high as 6 db per octave below midband,[4] which cannot be ignored. Each listener will have to compromise to his own taste between clean lows and missing lows.

In conclusion, the writer wishes to acknowledge a very special debt to Æ whose forward-looking policies have kept its readers in the forefront of the rapidly-advancing audio art.

[3] L. B. Arguimbau, *Vacuum-Tube Circuits*. New York: Wiley, Chap. VIII.
[4] H. F. Olson, *Elements of Acoustical Engineering*. New York: Van Nostrand, 2nd. ed., p. 126.

Radio's MASTER REPORTS

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

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

BOOKS AND MANUALS

JOHN F. RIDER. Increased prices on "Receiving Tube Substitution Guide Book" to $3.00 . . . "TV Installation Techniques" to $4.50 and "TV and other Receiving Antennas" to $6.00.

MISCELLANEOUS RADIO, TV, AND ELECTRONIC PARTS

AEROVOX CORP. Added 23 new capacitors to their line.

CHICAGO TRANSFORMER. Correction: reduced prices on their entire line amounting in most cases to less than 2%. Erroneously reported as a 10% reduction in March issue.

EBY SALES. Withdrew sockets 4523 and 4527 . . . added Harness 49-13DH at $1.29 net and Test Harness Kit K-301 at $3.60 net.

MALLORY & CO. Increased prices on 22 replacement magnesium-copper sulfide rectifier stacks.

R.C.A. Added TV Components 212R1 width control, 213R1 hor. linearity control. 230T1 hor. defl. output and HV transformer for 21AP4 . . . withdrew TV Components 201D1, 201D3, 201D75, 201S1 and 202X1 . . . withdrew RCA radio batteries VS007, VS018, VS027 while adding radio batteries VS057W at $4.03 net, VS073 at $.05 net, VS084 at $.80 net, VS085 at $.96 net and VS119 at $6.20 net.

SANGAMO ELECTRIC CO. Added 11 type MMT electrolytic capacitors and 11 type BTE electrolytic capacitors.

UNITED TRANSFORMERS. Added miniature audio units types H-1 to H-11 . . . Compact audio units types H-20 to H-24 . . . Subminiature audio units types H-30 to H-35.

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

BRITISH INDUSTRIES (Wharfedale). Introduced new Super-5 treble speaker with effective range 3,000 to 20,000 cps at $20.95 net.

JENSEN MFG. CO. Added type "C" bass reflex cabinets model C-81 (in blonde and mahogany) speaker size 8 in. at $25.00 net . . . Model C-121 (in blonde and mahogany) speaker size 12 in. at $33.16 . . . C-151 (in blonde and mahogany) speaker size 15 in. at $41.33 net. Added type "J" Peridynamic cabinet model J-81 for 8 in. speakers at $6.23 net . . . Model A-402 crossover network (crossover at 4000 cps, 16-ohm impedance input) at $6.75 net . . . Model RP-302 high-frequency unit (compact "super-tweeter." maximum power rating 30-40 watts speech and music signal when used with A-402 crossover network; impedance 16 ohms) at $33.60 net.

PERMOFLUX CORP. Withdrew baffle CB-8-M from their line.

QUAM-NICHOLS CO. Introduced AS-1 rear seat auto speaker at $5.97 net. Kit includes Quam 6½" PM Adjust-A-Cone speakers with 1.47 oz. Alnico V Magnet, 3 pos. switch. Also added AS-2 rear seat auto speaker at $8.37 net. Kit includes Quam heavy duty 6" × 9" PM Adjust-A-Cone speaker with 2.15 oz. Alnico V Magnet, 3 pos. switch.

R.C.A. Added PM type speakers 446S2 and 269S1 and withdrew PM type speakers 201S1 and 423S1.

RECOTON CORP. Added replacement needles 380 (Standard), 381 (Micro-Groove), and 382 (All Groove) at $.90 each.

TALK-O-PRODUCTS. Introduced CW-5, Cabinet Station at $36.00 list and FW-5, Flush Station at $25.50 list.

WILCOX-GAY. Withdrew their series of Recordio Tape.

TEST EQUIPMENT

ASSEMBLY PRODUCTS, INC. Added 15 "Simplytrol Pyrometers" and also 4539 and 4549 "Simplytrol Large Scale Controls."

BEAM INSTRUMENTS. Increased their prices on Standard Thermo-Couples (Vacuo-Junction) 5 ma-1000 ma to

$11.00 ea., 2.5 ma to $31.50 ea., and UHF Thermo-Couples from 5 ma up, to $16.50 ea. Prices are net. Reduced prices on Oscillograph Model 1035 to $599.50 net and Model 1049 to $889.50 net . . . also Pre-Amplifier Model 1430 DC to $390.45 net.

ELECTRONIC MEASUREMENTS CORP. Added Models 206 and 206P. Mutual Conductance tube testers.

PRECISE DEV. CORP. Added to their line of Electronic Test Equipment K-630, RF-AF-TV and Marker Generator . . . KA-630, same as K-630 with pre-assembled and pre-calibrated RF head . . . K-635, universal AF sine, square, and pulse generator . . . W-630, same as K-630 but wired . . . W-635, same as K-635, but wired.

R.C.A. Added Master Voltohmyst WV-87A at $112.50 net.

RADIO MFG. ENGINEERS. Added Mobile Converter MC-53 for 2, 6, and 10-11 meters at $66.60 net.

SIMPSON ELECTRIC CO. Model 445, 25,000-volt d.c. probe for television testing withdrawn . . . Added Model 276, Oscilloscope Calibrator at $29.50 net . . . also Model 880 Dynamometer Instruments—a.c.-d.c. and Model 9 (d.c.) series and Model 10 (a.c.) series.

TOOLS AND HARDWARE

DRAKE ELECTRIC. Decreased price of 900 "Instant Heat" solder gun to $9.00 net.

MINNESOTA MINING. Withdrew "Scotch" #24 Electrical Tape with neoprene backing.

PHILLIPS MFG. CO. Added 15 new items to their line of Phillips "Flash" soldering tools, parts and accessories.

UTICA DROP FORGE. Added two new compound-leverage, parallel-action pliers 402-6½" (with cutter) and 400-6½" (without cutter) . . . added new Plier-Snip 101-4½".

TUBES—RECEIVING, TELEVISION, SPECIAL PURPOSE, ETC.

EITEL-McCULLOUGH. Added three new Vacuum tubes: 3W5000A3, 3W5000F3, and 3X3000A1 all at $198.00 net each.

NATIONAL ELECTRONICS. NL-249C, half-wave rectifier added at $12.75 net.

R.C.A. Decreased prices on picture tubes 17TP4 to $25.75 net and 20CP4 to $39.00 net . . . added electron tubes 6082 at $530.00 net and 6166 at $780.00 net . . . increased prices of electron tubes 5946, power triode to $115.00 and 6161, UHF power triode to $115.00 net . . . 17 picture tubes now subject to dealer return allowance.

SHELDON ELECTRIC. Increased price of ten TV picture tubes in each of their Blue and White Label series while decreasing prices of six other TV tubes in these same series . . . Added 21AP4 at $42.65 net (Blue Label) and at $41.00 net (White Label) . . . and 21MP4 at $44.25 net (Blue Label) and at $42.50 net. (White Label).

SYLVANIA. Reduced TV picture tube types 16RP4 and 16TP4 to $27.00 net each . . . added three ten-inch tinted-face picture tube types to their Glass Allowance Program, 10BP4A, 10FP4A and 10MP4A.

TAYLOR TUBES. Added rectifier tubes TR40M at $20.00 list . . . 8013A at $10.30 list . . . and 8020 at $22.00 list.

Employment Register

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

★ Positions Open   • Positions Wanted

★ **Associate Wanted** in New York area for small custom high-fidelity amplifier and receiver manufacturer. Must be interested in Rolls Royce quality, but have advanced ideas off-the-beaten-path and be willing to contribute capital plus effort. Box 501, AUDIO ENGINEERING.

• **College Student,** would like summer job in recording field, New York City. Box 502, AUDIO ENGINEERING.

NEW LITERATURE

• **General Electric Co.,** Electronics Park, Syracuse, N. Y. has published a 31-page booklet on the subject of high-fidelity audio reproduction which is available from G-E dealers at a cost of 25 cents. Written by Mark Woodworth, Norm Cromwell, and Roy Dally, all G-E audio engineers, the treatise is directed to audio fans, engineers and servicemen. Titled "Why Variable Reluctance," the work contains 19 illustrations and 18 charts or diagrams, and covers a wide range of subjects within the field of high-quality audio. Particular coverage is given low- and high-frequency compensation, diamond and sapphire stylus comparison, and abrasive action of records. This is a virtual necessity for the audio fan.

• **Sola Electric Co.,** 4633 W. 16th St., Chicago 50, Ill. is now issuing a 22-page booklet which is the finest example of industrial cataloging to cross this desk in a number of moons. Titled Catalog CV-142, the booklet is the only up-to-date cross reference to the Sola line of constant-voltage transformers. In both technical value and artistic appeal, this new Sola booklet is wholly outstanding.

• **Lenkurt Electric Company,** San Carlos, Calif. is now distributing the first edition of a new house organ called "The Lenkurt Demodulator." The "Demodulator" is planned as a permanent project, and will be mailed regularly to individuals interested in the field of telephone and telegraph carrier equipment. Each issue will contain articles of pertinent interest in all aspects of carrier operation. Requests for copies should be mailed to the Company's Publications Department, and must include name, company, position, and address of the writer.

• **Chicago Telephone Supply Corporation,** Elkhart, Ind. is releasing Data Sheet 160, which illustrates and gives detailed technical analysis of a complete line of military-type variable composition and wire-wound resistors. Included are such data as humidity and electrolysis characteristics, leakage resistance, rotational life, voltage coefficient, and dielectric test.

• **Keystone Carbon Company,** St. Marys, Pa. includes a wealth of information never before published in an 8-page technical bulletin covering properties, performance characteristics, and application data on Keystone negative-temperature-coefficient resistance units. Discussed in detail are the four basic factors making NTC resistance units valuable to designers and manufacturers—(1) Negative temperature coefficient, (2) Suitability as measurement or control devices, (3) Stable and reproducible characteristics and (4) Useful physical properties. Ask for Bulletin 13.

• **Superior Electric Co.,** Bristol, Conn. announces the addition of Type 10 to its line of Powerstat variable transformers in a handsome 4-page folder which will be mailed on request. The Type 10 Powerstat is a new, compact model for providing variable a.c. voltage at 50, 100, and 150 watts. The new bulletin is complete with photographs, outline dimensions, and ratings. In writing ask for Bulletin P252.

• **P. R. Mallory & Co., Inc.,** 3029 E. Washington St., Indianapolis 6, Ind. will mail to interested parties copies of a new Product Index, in which is listed condensed information concerning Mallory electrochemical, electromechanical, electronic and metallurgical products. Included is data covering the complete Mallory line of batteries, capacitors, contacts, rectifiers, resistors, switches, vibrators, metals and ceramics, tuners, and resistance welding supplies. Semi-technical in nature, the index is designed for both engineers and laymen.

• **Wirt Company,** 5231 Green St., Philadelphia 44, Pa. is now distributing Bulletin No. 177 describing the company's complete line of wire-wound potentiometers, rheostats, and slide switches. All models are represented by illustration, dimensional drawings, and full technical specifications.

• **Barber-Colman Company,** Rockford, Ill. illustrates and describes its complete line of motors in a new small-motor bulletin which will be mailed on request. All motors listed are of the shaded-pole type. Shown are typical applications for the various models illustrated. An interesting brochure for quantity users of small motors.

CLASSIFIED

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

THE AUDIO EXCHANGE, INC. buys and sells quality high-fidelity sound systems and components. Guaranteed used and new equipment. Catalogue. Dept. AE, 159-19 Hillside Ave., Jamaica 32, N. Y. Telephone OL 8-0445.

FOR SALE: Ampex 400 tape recorder, portable case. Factory reconditioned, $695. H. Cravis, 186 Riverside Drive, New York 24, N. Y. SChuyler 4-3166.

ELECTRO-VOICE "Slim-Trim" Professional microphone, Model 655, cost $120, your price $95. Matched pair Pickering diamonds, 78 and 33, cost $60, your price $45. Money orders only, f.o.b. New York. R. Bennis, Box CA-1, AUDIO ENGINEERING.

McPROUD corner enclosure for 15-in. woofer and 2-way system. Beautiful limed oak, cost $200, for $135. 2 months old. Must be seen to be appreciated. Call after 6 p.m. ILlinois 8-8171.

FOR SALE: Twin-Trax 15-in. per second tape recorder mechanism. ACA Model 808C, in excellent condition, $55. Donnie Brown, 1305 Watson, Moberly, Mo.

WANTED: Model T-12 or T-12H Rek-O-Kut turntable, with or without arm. Give condition and lowest price. Box CA-2, AUDIO ENGINEERING.

IN LOS ANGELES, for custom music systems and improvements, call R. B. Stanton, RUgby 8-8621. Williamson amplifiers to order.

WANTED: Summer job, New York City. College student would like to work in recording field. Box CN-1, AUDIO ENGINEERING.

FOR SALE: Allied overhead recording mechanism in perfect condition. Complete with 96 LPI and microgroove feedscrews, spiralling device, rest stand, standard cutterhead mounting. Will cut discs up to 16 in. and is easily mounted on any recording or heavy-duty playback table such as Rek-O-Kut T-12 or larger. Mechanism and all accessories $121. Jac Holzman, 189 W. 10th St., New York City. OR 5-7137 after 3 p.m.

MAGNECORD, model PT6-A with PT6-J Amplifier, $425; Presto disc recorder, model K, $250; High-fidelity amplifiers—Altec, American Amplifier Corp., Stromberg Carlson, Goodell, from $70 to $180. H. Unfried, 3104 Main St., Buffalo 14, N. Y.

CUSTOM Williamson Amplifiers, two chassis, all filter capacitors oil filled, coupling capacitors bathtub, Acrosound output transformer $87.50. Transformer substitution on request. Dr. Nicely, Kenton, Ohio.

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

WESTMINSTER records $4.17 each (30% discount), postpaid. Quantity (5 or more) prices. The Record Loft, 189 W. 10th St., New York City.

3-SPEED PT6-AH & PT6-J Magnecorder; hardly used, perfect condition, $494. Box CN-2, AUDIO ENGINEERING.

PRESTO 6N, 1D head, advance ball standard and microwave screws, console-portable, blanks, sapphire styli, $425. W. E. 639 Mike, $145. Box CN-3, AUDIO ENGINEERING.

FOR SALE: 30-dial decade resistance box, 5 separate 6-dial decades, each range from 0.1 to 99,999 ohms, accuracy 0.1%. 27-in. Cinaudagraph loudspeaker, 2 million lines flux, ¾-in. travel, 85 watts, 6-in. voice coil, as described in June 1940 *Electronics*. Shipping wt. 600 lbs. Basket needs straightening. Each, highest offer over $300. Gottschalk, 37 W. 52nd St., New York 19, N. Y.

FOR SALE: IIIc Leica, f/3.5 Elmar 50-mm, case, good condition, $140. Ed. Dept., AUDIO ENGINEERING.

Industry People--

Jerry Kahn, president, Standard Transformer Corp., Chicago, holding nightly Audio Fair with himself as sole attendant—equipment on display is the new Kahn "loudspeaker," **Peter** by name . . . **Jim Pickett,** head of the New York chapter of the REPS, stirring up great interest in series of joint meetings in which the REPS and a sales managers' group will collaborate . . . **Lou Dezetel,** Allied Radio Corp. official, predicts that Easterners will get the surprise of their lives at the success of the Windy City's Audio Fair—says it is just what the doctor ordered for solidifying interest in high-quality audio in the Mid-west.

David Sonkin, prominent New York rep, gladdens hearts of friends with news of his recuperation from serious illness—is convalescing in Florida hospital . . . **Maximilian Weil,** chief engineer, The Audak Company, back on the job after well-deserved vacation . . . **Walter Godfrey,** president, River Edge Industries, River Edge, N. J., announces plan to introduce quality line of audio furniture at the Chicago Parts Show—will continue to manufacture present line of TV cabinets . . . **Buster Moffett,** NBC TV-development engineer, recovering from serious illness in Tarrytown, N. Y. hospital.

Jack Berman, sales manager, Shure Brothers, Inc., Chicago, made flying trip to Manhattan in connection with super-secret development the company plans to introduce in the near future . . . **Harry Houck,** president, Measurements Corporation, Boonton, N. J. taking justifiable pride in opening of new plant—both functional and beautiful, the new Measurements building is an industry criterion . . . **Emery Cook,** president, Cook Laboratories, Inc., reports increasing number of requests to include "Sounds of Our Times" recordings in audio catalogs.

. . . **William H. Linz,** Chicago, is new Midwestern representative for Peerless Transformers—announcement made by **E. B. Harrison,** Peerless commercial manager . . . **Stanley R. Andrews** is new vice-president of Standard Coil Products Co., Inc., Chicago—joined the company in 1945 . . . Entire electronics industry saddened at passing of **Dr. Lewis W. Chubb,** director emeritus of Westinghouse Research Laboratories.

J. H. DuBois is new v.p. in charge of engineering of the Mycalex Corporation of America, Clifton, N. J. . . . New president of Graybar Electric Co. is **W. E. Henges**—joined the company 39 years ago as receiving clerk . . **Clifford C. Rose,** formerly with College of City of New York, has joined uptown-store sound sales staff of Hudson Radio & Television Corp., New York . . . Election of **Adm. Wm. H. P. Blandy, U.S.N. (retired)** as director of Gray Manufacturing Co., announced by **Walter E. Ditmars,** president . . . Manhattan's Arrow Electronics, Inc., has new ad and sales promotion manager in person of **Harry Adelman,** electronics pioneer . . . **Russell J. Tinkham** being introduced in the Windy City as manager of new Chicago office of Ampex Electric Corp.

Industry Notes--

Audio Instrument Co., Inc., New York, headed by C. J. LeBel, founder of the AES, has doubled engineering and production space . . . **Howard W. Sams & Co., Inc.,** Indianapolis, entertained the company's sales representatives from all parts of the country at a "Hoosier Style" sales conference—reps were greeted by the mayor prior to business sessions. Two general meetings presented as speakers Howard W. Sams, Jack C. Keith, Donald B. Shaw, William D. Renner, and Joe O. Goetz, all Sams officials . . . **Jensen Manufacturing Co.** will feature a "Jensen Silver Anniversary Sound Theater" with continuous free public shows in conjunction with the Chicago Audio Fair May 23 and 24—free tickets can be obtained from Jensen distributors or by writing the company . . . **Gray Manufacturing Co.,** Hartford, Conn., has leased 23,000 sq. ft. of manufacturing space to provide additional facilities for its wholly-owned subsidiary, the **Gray Research and Development Co.**

Doubled sales have caused **National Cine Equipment, Inc.,** New York to engage larger space at 209 W. 48th St. . . . **P. R. Mallory & Co., Inc.,** Indianapolis, announces a half-million-dollar expansion program—will provide 35,000 sq. ft. of additional manufacturing space . . . **Electrical Reactance Corp.,** Olean, N. Y. has merged with **Aerovox Corp.,** New Bedford, Mass.—henceforth will be known as the **HI-Q Division of Aerovox.**

ADVERTISING INDEX

METERS ARE ACCURATE...

TALK IS NOT...!

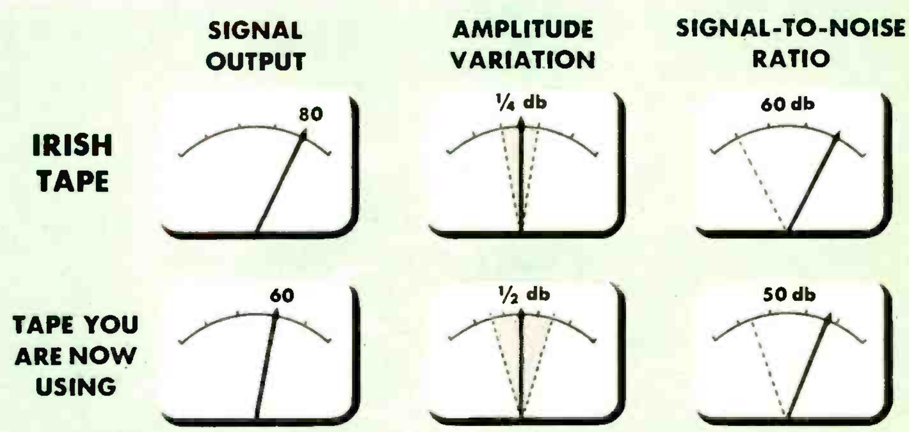
When an important conclusion is to be reached... when a dependable comparison is to be made... among several supposedly similar products... we do not rely upon conversation, claims and mere words! WE WANT FACTS...!

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

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

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

THE DIFFERENCE WILL BE STARTLING!



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

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

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

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

The Reason?

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

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

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

Manufactured in U.S.A. by

ORRADIO INDUSTRIES, INC. OPELIKA, ALABAMA

World's Largest Exclusive Magnetic Tape Manufacturer