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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 steep 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 AE, 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 (filshe registered U. S. Pat. Off.) is published monthly at 342 Madison Ave., New York, N. Y. Subscription rates—United States, $5.00 per year. Single copies $1.00 per copy. Indexed in U. S. A. All rights reserved. Radio Engineering and/or all other publications published on for 1952 by Radio Magazines, Inc. Entered as Second Class Matter February 9, 1950, at the Post Office, Lancaster, Pa., under the Act of March 3, 1978.
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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 effect-ively 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. Plies 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 baffle like a bushel. 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 trans-ferred between input and output of the selector network. Thus, for "loop" signals, the loop is effectively broken by the net-works.

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 shown 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 6H6. "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 drop in $R_1$ and the effective internal resistance of the source due to a 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 rep

[Continued on page 4]
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 Sends 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 R1, 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 R1 is equal to the 6F6 plate resistance divided by the grid-plate transconductance. C4 and the amplifier output transformer have been inserted by the writer; the inventor shows no C4 and indicates only B-plus and amplifier signal at the junction of R1 and C4, but it appears that the practical method is probably as shown.

Organ Recording

John Hays Hammond, Jr. (not to be confused) with Laurena 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]
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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 the low, powerful organ notes were mixed with the higher voices. The results were somewhat like the noise from the so-called "rans" that were available some years ago and which made a very indignant 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 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 72 feet long. The resonant frequency of the cord is such as to be below the audible range, and therefore effectively dampens 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 microphone 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.

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Let's Talk!

"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," E, Oct. 1950) is not one of these great strategies. 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 speakers would penetrate the 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? En.)

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 Baroque on the River Thames.

Vern Yeich,
39 E. Cassily,
Springfield, Ohio

Loudest Control Philosophy

Sir:

The Tenth 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 bought one and installed it in my

[Continued on page 10]

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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 which would be heard 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 proportions scaled down.

Now there is no question that we want to scale down music from symphony 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)
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EDITOR’S REPORT

HANDBOOK OF SOUND REPRODUCTION

E very 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 seventyninth 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.
they're different
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...

**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*

**Higher Frequency Response** • **Negligible Intermodulation Distortion** • **Better Tracking Characteristics**

**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. L., 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.

www.americanradiohistory.com
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—an integral part of the whole 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 an understanding 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 now well understood, 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 threads 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, 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 not like the things we

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

** 1394 Unionport Road, Bronx, N. Y.
make no conscious effort to perform. We see best if we do not strain to see, 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 it 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.

Experimenter 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 overloading at its most sensitive mid-frequency range, shifts the recognition of sound—which is pitch—from the hearing of a definite 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 the novice 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 pitch perception. This phenomenon is well mentioned before. Loves, although heard, sound strangely flat and distorted, highs are piercingly shrill, roll-tones are 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 audition fatigue incapacitates the 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 idiosyncrasies both to lighten his labors and to perform more artistically.

One of the idiosyncrasies 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 recent, pid, or inherited—we cannot conceive of a sound that is not natural. (Have you never been frightened by a strange sound?) When a sound 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 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. There is a time, however, 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 colored, and so many other factors, but the point 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 analogous 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. Consideration of the persistence of sound 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? Shocks in a pistol shot are far back as Helmholz, 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...
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.

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.

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**

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<tr>
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<td>Switchcraft 12A jack</td>
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<tr>
<td>J₅</td>
<td>Amphenol 91-PC3F receptacle</td>
</tr>
<tr>
<td>J₆</td>
<td>Switchcraft 11 jack</td>
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<tr>
<td>J₇</td>
<td>Jones P-306-AB plug</td>
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<td>Amphenol 91-MG3M, on 6-ft. 3-wire cable</td>
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<td>P₂</td>
<td>Jones S-306-FLT, shunted between terminals 2 and 4</td>
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<td>Sw₆</td>
<td>Switchcraft 203 push button</td>
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<td>T₃</td>
<td>Output transformer, pp plates to line, 20,000: 600 ohms; ADC 315B</td>
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<td>V₇</td>
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**TRANSFORMER SUBSTITUTIONS**

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<td>A-11</td>
<td>HA-114</td>
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*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 8 1/4 in. wide, 8 in. deep, and 5 3/4 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 is used to feed the recording 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—may be 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 J1 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 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 \( V_R \), \( V_J \), and \( V_J \) is connected straight through, and may be used as desired, making the output connections to terminals of \( J_6 \). The second channel consists of \( V_I \), \( V_{IR} \), and \( V_{IR} \), 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. \( J_6 \) 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 \( T_1 \) will be available at the output of \( V_s \) at \( J_6 \).

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.

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.

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 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 $R_o$ equals the minus of $R_f$, the circuit.

[Continued on page 57]

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

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

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* 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.

OUDSPEAKER 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 AE 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 $R_{ve}$ 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 $R_{ve}$—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 the same thought is expressed by Clements when he says that the Childs amplifier oscillated at negative-resistance values approaching $R_{ve}$ because it is "too good." This statement was that $Z_m$ becomes nearly zero at "frequency extremes," at which time only $R_{ve}$ 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 $Z_m$

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ULTRIC J. CHILDS

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

AUDIO ENGINEERING • MAY, 1952

21
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 neglected, this voltage component \( e_1 \) is as follows:

\[
e_1 = \frac{e_1 \cdot r_p \cdot R_g}{r_p + R_g + R_e}
\]

where \( r_p \) is the plate resistance of the preceding tube, \( R_e \) 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 \( e_1 \) 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.

**Fig. 3. Typical R-C coupled amplifier with correction network—consisting of \( C_0, T_1, \) and two potentiometers—arranged to provide cancellation voltages to grids of succeeding stages.**

(Continued on page 53)
Sensation in Bass!

**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 face. 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, 15½" 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 ± 3 db down to 30 cps. 37½" high, 20½" deep, 23½" 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, 19½" 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. 37½" high, 23½" wide, 20½" deep. Complete, in Mahogany. List ... $465.00 Complete, in Blonde. List ... $473.00

**Model 108 Standard 800 cps Separate 2-Way Speaker System.** Consists of 12W-1 L-F Driver, T-10 H-F Driver, B-HD Diffraction Horn, X-81 Crossover Network, flat baffle board and AK-1 Accessory Kit of mounting hardware. 27½" high, 18½" 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, B-HD Diffraction Horn, X-81 Crossover Network, flat baffle board and AK-1 Accessory Kit of mounting hardware. 27½" high, 18½" wide, 12½" deep. List Price, less cabinet ... $255.00

**Model 114 Super 800 cps Separate 2-Way Speaker System.** Consists of 15W-1 L-F Driver, T-25 H-F Driver, B-HD Diffraction Horn, X-81 Crossover Network, AK-1 Accessory Kit of mounting hardware, and flat baffle board. 23½" high, 22½" wide, 13½" deep. List Price, less cabinet ... $265.00

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- MICROPHONES
- PHONO-CARTRIDGES
- TV SELF-TUNING BOOSTERS
- TV DISTRIBUTION SYSTEMS

**Audio Engineering • May, 1952**
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 designers-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 itself, which appeared last month on the cover of AE, 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 shell 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 carpenter 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 32]

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.
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.

DEMONSTRATION EXHIBIT • STROMBERG-Carlson
Conrad Hilton Hotel • Rooms 619A and 620A

Audio Engineering • May, 1952
Cabinet Design for Hi-Fi Systems

Jeff Markell*

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

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.

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

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

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.

www.americanradiohistory.com
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 1/2 x 12 x 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 be comfortably in a space 14 x 10 x 10 in., but when designing for general use rather than for a specific chassis, it is undoubtedly safer to allow 17 1/2 in. rather than 14 in. inside the front. Furthermore, the differential in cost for the additional 3 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 1/2 x 12 x 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 pre amplifier measures up to the performance requirements for a satisfactory home system.

The complete amplifier includes a control unit and preamplifier which is 25/4 in. high, 105/4 in. wide, and 75/4 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 coaxial 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 some where 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, 35 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 February 1949.

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.

Signal Input Voltages

For 1-watt output

(1000 cps, volume control maximum, tone controls "flat")

<table>
<thead>
<tr>
<th>Input</th>
<th>Voltage</th>
</tr>
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<tbody>
<tr>
<td>Mag. PU, 78</td>
<td>.0024</td>
</tr>
<tr>
<td>Mag. PU, LP</td>
<td>.0028</td>
</tr>
<tr>
<td>Crystal</td>
<td>.08</td>
</tr>
<tr>
<td>Radio</td>
<td>.08</td>
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Audio Engineering • May, 1952
Jensen celebrates its Silver Anniversary this year with an outstanding series of loudspeakers for high fidelity sound reproduction...loudspeakers of unprecedented importance to everyone seeking the finest quality attainable today. They are described in a comprehensive Brochure (publication date May 15) which will be sent free on request.

See and hear Jensen's finest loudspeakers at the Audio Fair in Chicago, May 23-24, Conrad Hilton (Stevens) Hotel. Plan to attend the free "Jensen Silver Anniversary Sound Theatre," Tower Room, featuring the "Reproducer of the Future."
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 outlooker 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 amplifiers, 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 amplifiers 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 carried 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: part of Magnecord's exhibit, which included a binaural demonstration; Mississippi broadcasters Cy Bahakel (left) of WKOZ in Kosciusko and Charles W. Holt of WMSY in Natchez with the "ears"; Freyo's medium-priced console recorder; and RCA's new fine-groove transcription turntable.
The first commercial amplifier without an output transformer. High damping factor. Frequency response: ± 1/4 db 20-70,000 cps. Distortion less than 1/2 of one percent at full 20 watt output. Phase shift less than 15 degrees at 20 cps.

$135.24 Net

The 5106AX, a new 300 ohm voice coil co-axial speaker. The perfect companion for the 200 D Amplifier. SPK — 5106AX...

$131.57 Net

A complete high fidelity amplifier system consisting of Model HD10 All-Trade Main Amplifier and Model RPX Pre-amplifier and Remote Control. Main Amplifier provides peak 25 watt output with .3 at 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 phone turn-over frequencies. UL approved. Complete with Tubes and Remote Control, Pre-amplifier.

$147.15 Net

RECORDING SPEEDS: 15 inches/sec., or 7 1/2 inches/sec., interchange-able. (No tools required.)

RECORD OR SPEED: Full 37 inch reel (1200 ft. of tape) rewound in approximately 40 seconds.

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Same with 3-mil Stylus for 78 rpm records...

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

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EDWARD TATNALL CANBY

More than an Earful

The Seventeenth Century

Henry Purcell, of the 17th century, was a busy yet introspective composer who ranks as England's greatest. His music was hosted 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 Mass (a sort of sacred 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 drearily distorted in many spots. Even so, easily listenable. France is still behind.

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

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 tremolo 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.

Purcell, King Arthur. Solo voices and choir dir. Fritz Kramer. Magic-Tone MLP 1006

(Continued on page 34)
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)

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"Creator of Fine Electro-Acoustical apparatus for over 25 years."
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 backslab artists through some good paces, unjustly 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 Reynolds. 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 lug-wobbly solo singers are; not an owner of the vigor and warmth that the music so obviously has in it. "Rejoice in the Lord, Alas!"—and these voices mumble the inspiring words like so much mashed potatoes!

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

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


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 first hearing as Purcell, but Bach lovers (and Handel) will catch on fast. The solo cantatas are excellent here, far superior to the Patrick Newar performances on Allegro; recording is excellent too. The Missa Brevis, composed ostensibly 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 "counter-tenor"—soprano among the soloists, plus an inconsistent piano in one piece, harpsichord in another. I'd give this a qualified O. Recording is flat; 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, Groshier. 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 phrase, 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 "Exequies" (Requiem) is a complex and brilliant concerto for voices (with instruments), the solo group and chorus contrasted to degrees of ways; the fresh, enthusiastic picking 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 provisio) 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 cleanliness. (See also the earlier St. John Passion by the Stuttgart group.)

Monteverdi. Psalms: Beatus Vir, Laudate

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

Schütz, Four Sacred Concerti; Four Symphoniae Sacrae. Hugues Cuencod, members Vienna Symphony, Pinkham.

Westminster WL 5043

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

Allegro AL 79

Monteverdi, Tiri 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 Scuola 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 muddier, the diction not clear; a bit harder to take, in spite of excellent performance.

Hugues Cuencod and Yves Tinayre are tenors, their recordings are all solo. Cuencod 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.


Allegro alg 3038

Back to England—and to the wobbling solo voices of this Cleveland church choir. Intentionally 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—20 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 Ensemble, Fleetwood.

Allegro alg 3019

Solo ensembles and chorus both sing in our familiar Apollonian church-choir manner; OK for the 17th 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

Brahms, Symphony #2. London Philharmonic, Furtwangler. London LL 28

A remarkably gentle, sweet performance—welcome change after too much forced pomposity in this over-enthusiastic symphony. Interesting notes: the long 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.

Dvořák, Symphony #4. Amsterdam Concertgebouw, Sijmen. London LL 488


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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 of recorded melodiously with good firr technique. (Some prephasis as directly compared with the Brahms above.)

Concert Hall's 4-way Dvorak LP is an outstanding technical job. Very hardly recolored but surprisingly free from distortions—whenever cut this master did a fine job. The coloring is just "right"—this is that perfect 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 1133

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 PS158

Now, now, Capitol! After all the fanfare over FDS (Full-Dimensional Sound—see April), this makes strange listening. Same orchestra, same conductor for both sides. But, apparently, an utterly different curve: the Arensky plays fine with usual slightly-less-than-NAB 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) Mitterer, Piatigorsky; Robin Hood Dell Orch., Reiner. RCA Victor LM 1191

Technically an interesting comparison—since the Westminster happens to be a 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 superb-bright with a highly accurate bass, fine solo tone, sharp, close-up perspective (too close); would rate tops technically if it had the liveliness indispensable to this Romantic music. The Robin Hood (Phillips 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 solo good.


Of great interest to anyone who knows the familiar Strauss— Till 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-raising; but I like it better than the Vieuxtemps and Lalo and what not that violinists usually inflect. The oboe work, from his mid-eighties, is serene, calm, melodic, economical, modest—all of the compositional, the cruelty, the overbearing egoman in the earlier man (however brillant it all was) is utterly gone. This is a calm, golden evening of music without a trace of modernity, one sense, a final resolution 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 uniformly 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)

Vox PL 7350

Mose 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 hear time to, something that hits them straight on the ear-drums"— a very apt remark for today. Very nice recording, performances on a revamped and colorful baroque organ (doesn't sound churchly), 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, Woldike.
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 slower 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 Nazis— faultlessly, and more naturally than plenty of our own choirs! Got to hand it to them. Top recording of the sort.

Meet the Teleloud

A new 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 disconnects the connection. Power supply is obtained from regular a.c. lines.

Designed and patented by Fred L. Cunow, "Teleloud is going through a process of commercial development, and is expected to be available to users by next fall.

PHONOGRAPH ACCESSORIES

New Reversible Stylus (RPJ-013) incorporates sapphire tip for standard play and diamond tip for LP and 45's. "Double twist" arm permits stylus to follow every tiny recorded groove. Ask your G-E dealer for a demonstration today.

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

Vox PL 7350

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

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

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CABINET DESIGN

An amplifier that requires more mounting space than this—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 center, 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 present by the time you have brought out from three to seven tuner controls, and from three or five pre-amp controls.

Several of the tuner controls are, of course, duplicated on the pre-amp. This is at least 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 "Woofers" 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 3/8-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 blame 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—5 3/4 cu. ft.
- 10-in. "—6 3/4 cu. ft.
- 12-in. "—8 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 motor 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 preboard, 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...
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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. Sufficient 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, moldings, 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 3/4-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 unit 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 3/4-in. plywood is preferred for the cabinet itself, but legs, railings, 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

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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 $R_3$, $C_3$, $C_4$, and $R_4$, is placed 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 $R_4$, mounted on or geared to the control bar, is at the top of $R_4$, grounding the bottom of $C_4$ and greatly attenuating the high-frequency response of the system. The response is restored, however, by $R_4-C_4$, a standard high-boost circuit.

As the bottom of the pedal comes down and the shutters close, the control bar comes down, too. More and more of $R_4$ is inserted between $C_4$ 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.

---

**Fig. 3.**

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**Book Reviews**


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 practice.

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 interests lie. 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 treat 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.

—L B Krinn


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.

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—H. A. Chinn

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 plantatron, sanatron, and sanaprant. 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.

—J. Goodfriend


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.

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- 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 11 1/2 x 8 1/2 x 5 1/2 ins. and weighs only 9 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 it is necessary, thus ensuring program continuity. Battery life is 160 hours. Tape speed is 1 5/8 ins./sec., permitting two hours of recording on a single 5-in. reel. Frequency range is up to 5600 cps. The "Interviewer" permits automatic monitoring while recording. It also contains its own playback preamplifier for feeding headphones, an external amplifier and speaker. Complete descriptive material will be mailed free on request by Amplifier Corp. of America, 399 Broadway, New York 13, N. Y.

- Magnetic Tape Mailing Carton. Both professional and amateur recordists will welcome a new carton for mailing and re-

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teries. The 1551-A is equipped with a phragm-type Rochelle-salt microphone. General Radio Company, 475 Massa-

chusetts 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 intro-

duced 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 shunts off the entire music system after the last record is finished, have been re-

tained. Although the new models repre-

sent considerable improvement over previous ones, prices remain unchanged. V-M Corporation, Benton Harbor, Mich.

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quency unit for extending the frequency range of existing two-way speaker sys-

tems. Constructions features include a Bakelized cone and an aluminum voice coil. Flux density is 14,000 lines. Effective frequency range of the Super 5 is 3000 to 20,000 cps. Typical of other Wharfeldale 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 3 1/2-in. diameter aperture, which is the effective cone diameter. May be used with two-speaker systems employing 1000-cycle crossover merely by connection in parallel with the present treble unit and by inserting a small jack in series with the voice coil of the Super 5. British Industries Corporation, 164 Dunne St., New York 13, N. Y.

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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 $R_m$ 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 $R_m$ 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

$$ e = \frac{Z_m + R_m}{Z_m} $$

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 $R_m$ 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 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 amplifier, 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 cabinet with about 15 cubic feet of internal air space.

Determination of the motional imped-
rance of the speaker system was made by two methods, both involving actual measurement of the total impedance and substitution that figure of \( R_m \) 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 with 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 \( R_e \) is equal to \( R_m \) (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 \( R_e \) is reduced to a value which does not entirely cancel out \( R_m \), 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 shown by the center curve of Fig. 2. Incidentally, the value of 6.5 ohms for \( R_e \) 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 flutter 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.

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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 0.55 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-fealessness. 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 a 10 ft. 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 elapsed 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-effect 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.

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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 reach 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 cutters 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 with 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 finished, 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 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 $e_i$ and $-ke_i$ are negligible compared to the constants of the remainder of the circuit, then considering generators $e_i$ and $-ke_i$ separately,

$$i_i = \frac{e_2}{e_1} \frac{\sqrt{(R_L + R_P)^2 + X_Z^2}}{e_1}$$

$$i_k = \frac{\frac{e_2}{e_1}}{\sqrt{(R_L + R_P)^2 + X_Z^2}}$$

If $i$ is the resultant current, then

$$i = i_i - i_k$$

$$i = \frac{e_2}{e_1} \frac{\sqrt{(R_L + R_P)^2 + X_Z^2}}{\sqrt{(R_L + R_P)^2 + X_Z^2}}$$

$$i = \frac{e_2}{e_1} (1 + k)$$

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In order that the voltage across the grid of the tube be zero, then
\[ e_i - i_R D = 0 \]
Substituting for \( i \) in the portion of the equation to the right, then
\[ e_i - i_R D = -ke_i + \frac{k e_i}{(1+k) R_L} \]
If \( e_i \) is unity and \( X < R_L \) or \( R_w \), then
\[ k e_i \left( \frac{1}{1+k} \right) R_L \]
Therefore \( R_w = k R_L \)
However, it is to be noted that the voltage \( (e_i - i R) \) produces a current through the dynamic plate resistance of the tube. If \( X_s \) is small, the voltage \( (e_i - i R) \) is essentially equal to the voltage \( e_i \) 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 \( k X \), is introduced in series with grid resistor \( R_g \) and shunted by a high resistor, then the effect of the capacitance \( X \) 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 \( C_L \).

The noise voltage \( E \) can be considered as a constant-voltage source. In the equivalent circuit, \( R_L \) and \( R_L \) are resistances in the primary and secondary circuits.

Transformer Equivalent

The response characteristics of the audio transformer \( T \), 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:

\[ L_{eq} = L_1 + L_2 \]
\[ R_{eq} = \frac{R_s}{n^2} \]
\[ C_{eq} = \frac{C_s}{n^2} \]

In the equivalent circuit, \( L_{eq} \) is the primary magnetizing inductance and \( R_{eq} \) is the secondary winding resistance referred to the primary. \( R_s \) is the external circuit resistance, which becomes \( R_s/n^2 \) 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 \( C_0 \).

(b) High-frequency series resonance between \( L_p \) and \( C_0 \). The ratio of \( L_p \) to \( L_m \), 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 \( L_p \) 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 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 high-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, as a consequence of the frequency becomes less. It was found possible to adjust the parallel resonance of a Thomson T-57A36 transformer to 120 cps by shunting the transformer secondary with a small capacitor of less than 200 muf. Such a capacitor will essentially 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 circuit of phase correcting portion of Fig. 3.

![Fig. 4. Equivalent circuit of phase correcting portion of Fig. 3.](image)

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![Image of amplifier circuit](image)

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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 noise 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 R1 and R2. 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.
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Audiography

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Audiography • May, 1952

POSITIVE FEEDBACK

[From page 20]

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

notional impedance of a loudspeaker is roughly a parallel-resonant circuit on the electrical side.

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 $R_n$ equal to the minus of $R_g$, the current is, of course, infinite. Here we have an interesting mathematical anomaly. The only energy coming into the circuit is through $R_g$ and the only energy leaving the circuit is through $R_n$. 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 input signal into sound and cannot be the same energy that turns into heat in the voice-coil. The trouble with Fig.


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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.

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:

\[ \frac{e}{B} = \frac{Z_p + R_p}{Z_m + R_m + R_p} \quad (1) \]

\[ \frac{e}{B} = \frac{Z_p + R_p}{Z_m + R_m} \quad (2) \]

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-coil resistance was 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
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 restrict 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 \( Z \), 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 boss 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 \( \& \) whose forward-looking policies have kept its readers in the forefront of the rapidly-advancing audio art.


---

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**Write for Shallcross Data Bulletin R3A**

Shallcross Manufacturing Company
Collingdale, Pa.
A MONTHLY SUMMARY of product developments and price changes of radio and television electronic 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 in the Official Buying Guide, Radio's Master—available through local radio parts wholesalers.

BOOKS AND MANUALS

JOHN F. RIDER. tacos. 100 pages. $3.00.

MISCELLANEOUS RADIO, TV, AND ELECTRONIC PARTS

AERVOX CORP. Added 22 new replacement television or audio components. $2.50.

CHICAGO TRANSFORMER. Corrected: reduced prices on their entire line amounting to small savings of less than 2%. Extensively reprinted at a 10% reduction in March issue.

EVB SALES. Withdrawed model 4209 and 4227. Added models 49-1200 and 49-1300, with tubular kit K-301 at $10.50 net.

WASHINGTON & CO. Added new prices on 22 replacement type-sets for identical style and size in new price range.

R.C.A. Added TV Grandmaster 1216B, 1216B, 2210D2, 2210D2, 2210D2, 2210D2. Withdrawed VCA radio master 1216B, 1216B, 1216B, 2210D2

SANGAMO ELECTRIC CO. Added 11 new type MMT ellipsoidal carbodies and 1 type RTE electrolyte capacitors.

UNITED TRANSFORMERS. Added starting units.

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

BRITISH INDUSTRIES (Wharfedale). Introduced new Bronze-5 triple type speaker with driving range 3,000 to 20,000 c.p., 2.5 units.

JENSEN MFG. CO. Added type "C" bass reflex cabinets, model J-51 (for blonde and mahogany) speaker size 8 in. at $35.00 net... Model J-151 (in blonde and mahogany) speaker size 8 in. at $35.00 net... Model J-502 (for blonde and mahogany) speaker size 8 in. at $35.00 net... Model J-503 (for blonde and mahogany) speaker size 7 in. at $35.00 net... Model J-504 (for blonde and mahogany) speaker size 6 in. at $35.00 net... Model J-505 (for blonde and mahogany) speaker size 5 in. at $35.00 net... Model J-506 (for blonde and mahogany) speaker size 4 in. at $35.00 net... Model J-507 (for blonde and mahogany) speaker size 3 in. at $35.00 net... Model J-508 (for blonde and mahogany) speaker size 2 in. at $35.00 net... Model J-509 (for blonde and mahogany) speaker size 1 in. at $35.00 net... Model J-510 (for blonde and mahogany) speaker size 0.5 in. at $35.00 net...


PERMOLUX CORP. Withdrawed model Q-15 from their line.

OHN-NICHOLS CO. Introduced AS-1 reel-to-reel tape record. $12.50 net. Kit includes: 1/4" 7-pc. tube, 12" spool, 3 mm. switch... Also added AS-2 reel-to-reel tape record. $25.00 net. Kit includes 10-mil heavy duty 6" x 6" PM... Tube... Also added 14-pc. tube, 12" spool, 3 mm. switch...

R.C.A. Added PM type recorders 4468S and 4468B, and withdrawn PM type recorders 4366S and 4366B.

Nikon Corp. Added replacement cartridges 310 (Standards), 311 (Silver), 312 (Greens), and 313 (All Greens) at $9.00 each.

TAPE PRODUCTS. Introduced CT-3, Cabinet Model at $26.00 list and CT-3, Phase Station at $33.00 list.

WILOX-GAY. Withdrawed their series of Reel-to-Reel Tape.

TEST EQUIPMENT

ASSEMBLY PRODUCTS, INC. Added new "Bumpfend Pumps" model and added 4450 and 4451 "Carpenter Lanes" Scale Consoles.

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

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Portable Tape Transport Mechanism with Matching Fully Wired Pre-Amp and Bias-Erase Oscillator

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Write for Bulletin 102

www.americanradiohistory.com
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 sent to 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.

**Audio's New LABORATORY INSTRUMENTS**

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Model 165 IM Meter is especially suited for laboratories, broadcasters, recording studios. Signal generator, analyzer, voltmeter in single case. Roads 10 M, amplifier output directly on meter. Provides for ease of scope to analyze 5 & 9 IM causes. Full graphic instructions supplied. Wide range of low & high test frequencies: 60 cps internally, 50-200 cps externally; standard 2, 13, 15 kc externally; 2-20 kc externally. Voltage ratio choices: LF testing, 1:1; for HF accurate IF testing, 1:1.15 V: X 19" rack type panel; 83" deep. Price $250.00.

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NEW LITERATURE

- General Electric Co., Electronics Pars, 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 Max Trombone, Norm Crosswell, and Roy Daily, all G-E audio engineers, this booklet is directed to audio fan engineers and servicemen. Titled "Why Variables Matter," the work contains 19 illustrations and 13 charts or diagrams, and covers a wide range of subjects within the field of high-fidelity audio reproduction. Particular coverage is given low- and high-frequency compensation used in diamond and sapphire stylus comparison, and abrasive action of a stylus. This is a virtual necessity for the audio fan.

- Sola Electric Co., 4633 W. 16th St., Chicago 36, Ill., is now issuing a new 22-page booklet which is the finest example of individual covering across the deck in a number of moons. Titled Catalog CV-142, the booklet is the only up-to-date reference to the Sola line of constant-voltage transformer. In both technical and artistic details, this new Sola booklet is wholly outstanding.

- Lenkurt Electric Company, San Carlos, Calif., is now in its first edition of a new house organ called "The Lenkurt Remodeling Bulletin." The bulletin is planned as a permanent project, and will be mailed regularly to individuals interested in the field of telephone and telegraph systems. The bulletin will contain articles of pertinent interest in all aspects of communications. Requests for copies should be mailed to the Company's Publications Department, and must include name, position, and address of the writer.

- Chicago Telephone Supply Corporation, 111 S. Dearborn St., Chicago 4, Ill., which illustrates and gives detailed technical analysis of a complete line of military-type variable composition and wire- and braid-systems. Included are such data as humidity and electrolysis characteristics, leakage resistance, relative life, voltage coefficient, and diode test.

- Keystone Carbon Company, St. Mary's, Pa., is preparing 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 resistances useful to designers and manufacturers: (1) Negative temperature coefficient, (2) Suitability for measurement or control devices, (3) Stability of resistance with time, 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 receipt. Powerstat is a new compact model for providing variable a.c. voltage at 20, 100, and 186 volts. The new Bulletin is complete with photographs, outline dimensions, and ratings. It is intended for Bulletin P252.

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

- Wirt Company, 5211 Green St., Philadelphia 41, Pa., is now publishing Bulletin No. 127 describing units covering its complete line of wire-wound potentiometers, rheostats, and sliding contactors. All models are represented by illustration, dimensional drawings, and full engineering 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 announcements. Minimum charge $5. No price reductions for a series of announcements. Rates are net, and no discounts will be allowed. All copy must be in type, typewritten, or carbon copy, and must be 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, new and used, and all equipment. Catalogue. Dept. AE, 159-19 Hillside Ave, Jamaica, N. Y. 11416, OL 8-0441.


FOR SALE: Twin-Tez 15-in. per second time recorder. Complete with 90 LPI and microgroove recorders, spiralling device, test stand, standard cut-out mounting. Will cut discs up to 16 in. and is easily mounted on any recording or cutting machine such as Rek-O-Kut 512 or larger. Mechanism and all accessories $112. Joc Hoskins, 327 N. 12th St., New York City, 5-1379 after 2 p.m.

MAGNEOCHORD, model PT-6A, with PT-6J Amplifier, $435; Proto disc recorder, model K, $200; High-fidelity amplifiers—Altec, Jensen, Amplifier Co., Goldwell, from $70 to $180. H. Undri, 3104 Main St., Buffalo 14, N. Y.

CUSTOM Wolverine Amplifiers, two channel, filter capacitors in Bins, coupling capacitors, tubatube, Aerobed output transformer, $150. Transformer substitution on request. Dr. Nicely, Kenton, Ohio.

WANTED: Jensen 18 in. Audition speaker, model M18-JC. C. C. Donnell, 79 Dover St., Dayton 10, Ohio.

WESTMINSTER records $4.17 each (30% discount), postpaid. Quantity (5 or more) price $3.57 each Lot 1, 180 W. 10th St., New York City.

SP-SPEED PT-6-AH & PT-6J Magnecorder—hardly used, perfect condition, $491. Box CN-2, Audio Equipment.

PRESTO 6N, 1D head, advance bajt, standard and microwave screws, console portable, black, $295.95; model 250, $185. Model 350 box. CN -3, Audio Engineering.

FOR SALE: 30-die decade resistance box, 5 separate 6-die decades, each range from 0.1 to 9,999 ohms, accuracy 0.75%. CimaGraph knob, 2 million line mark. $45. S. R. travel, 85 to 900 ohms, as described in June 1940 Electronics. Shipping weight 24 lbs., $55. Gotschalk 24, N. Y. 22nd St., New York 14, N. Y.

FOR SALE: 115 Leica, f/2.5 Elmar 50 mm, case, good condition, $140. Ed., Dept., Audio Engineering.

AUDIO ENGINEERING • MAY, 1952
Industry People--

Jerry Kahn, president, Standard Transformer Corp., Chicago, making mighty Audio Fair with himself as sole attendant-- "Arrangement on display is the new Kahn loudspeaker," Peter by name, Jim Pickett, head of the New York chapter of the REPS, stirred up great interest in series of joint meetings in which the REPS and a sales managers group will collaborate. Leo Del Pizzo, Allied Radio Corp. official, predicts that Easterners will get the surprise of their lives at the success of the Windy City's Audio Fair--so it is just what the industry 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--convalescing in Florida hospital...Maximilian Weil, chief engineer, The Audak Company, back on job after well-deserved vacation...Walter Geoffrey, president, River Edge Industries, River Edge, N. J., announces plans 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 of the company's plans to introduce the near future...Harry Mouch, president, Measurements Corporation, Boonton, N. J., taking judicious 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 catalogs.

William H. Linn, Chicago, is new Midwestern representative for Peerless Transformers--announcement made by E. B. Harrison, Peerless commercial manager...Stanley H. Andrews, new vice-president of Standard Coil Products Co., Inc., Chicago, joined the company in 1945...Entire electronics industry saddened at passing of Dr. Howard Young, chief engineer, 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 Gray Stoves Electric Co. is W. E. Menges--joined the company 25 years ago...Cdward C. Rose, formerly with College of New Jersey, has joined uppermost-store sound sales staff of Hudson Radio & Television Corp., New York...Election of Adm. Wm. H. P. Blanpied, V.M.S. (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 F. Tinkham being introduced in the Windy City as manager of new Chicago office of Anpec Electric Corp.

Industry Notes--

Audio Instrument Co., Inc., New York, headed by C. J. Lefler, Thursday of the AES, has doubled engineering and production space...Howard W. Sama & Co., Inc., Indianapolis, entertained the company's sales representatives from all parts of the country at a "HOOCHY STYLE" sales conference--reps were greeted by the mayor prior to business sessions. Two general meetings presented as speakers Howard W. Sama, Jack K. Keith, Howard B. Scher, William D. Renner, and Joe O. Giddens, all Sama officials. Jensen Manufacturing Co. will feature a "Jensen Silver Anniversary Sound Show" with continuous free public shows in conjunction with the Chicago Audio Fair, May 23 and 24--free tickets can be obtained from Jensen distributors by writing the company.

Gray Manufacturing Co., Hartford, Conn., has issued 75,000 sq. ft. of manufacturing space to provide additional facilities for its Jensen subsidiary, the Gray Research and Development Co., doubled sales with National Cine Equipment, Inc., New York, to encourage space at their outlet...P. R. Mallory & Co., Inc., Indianapolis, announces a half-million-dollar expansion program--will provide 35,000 sq. ft. of additional manufacturing space...Electrical Resistance, Inc., Salem, N. Y., has merged with Aerovox Corp., New Bedford, Mass.--former will be known as the H-Q Division of Aerovox.
WHAT WILL A DOLLAR BUY?

For some few years we have been offering a technical service and a copy of our little booklet "New Notes in Radio" for the modest sum of one dollar. Most correspondents said they had no idea what it was all about but sent their dollar bill and hoped for the best. No renewal subscription is required because we don’t send out regular mailings of “red-hot info.”

Many have told us it is the best dollar’s worth they have ever had; we honestly don’t think they have yet had their money’s worth, but we have taken the dollars and will go on sending out stuff from time to time without regard to what it costs us.

Technical information has been sent, and more will come later, but the idea behind that dollar was not to sell you technical data sheets, but to enrol you in a new sort of society. The subscribers may not have realised this, but it is the case just the same, and the membership extends all over the U.S.A. and elsewhere.

The present mailing gives little technical information but very much on an entirely different subject. It is all tied up with audio, and an interest in audio is what holds the members together; what holds them even tighter is an interest in Hartley audio.

But whereas the Hartley audio program in America centred round the 215 speaker, which now more than ever is held to justify our original claim that it would please you better than any other at any price, that program is now very considerably enlarged, and in a way that is novel and profitable to you.

There is no space to tell you more here, but if your curiosity is aroused, the risk involved is just one dollar. What you will get at once is something that will make you think, and above all when you deal with us you must think, because the appeal of Hartley audio and Hartley marketing methods are not for the emotions, but for the brain. That is why no high-powered sales talks ever appear in this column.

In a few words Hartley audio is coming to you in a new and better form in a new and more convenient way, the only unchanged thing is the 215 speaker, for we frankly don’t know how to improve it yet. But everything else we make and do can be improved, and those improvements are described in the current mailing.

Our catalogue is, however, always free for the asking, and with that is sent a comprehensive technical report on the performance of the 215 speaker.

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

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

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

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

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Radio Company
Quincy, Illinois

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

Fuller data, including square-wave tests, distortion curves, etc., together with list of U. S. agents and dealers in Canada, is supplied to the person who requests it.

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Write for Bulletin 2101

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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.

**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.

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**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!**

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<td>TAPE YOU ARE NOW USING</td>
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<td>60</td>
<td>1/2 db</td>
<td>50 db</td>
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**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.

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FOR FILTERS

BROAD BAND SHARP CUTTOFF FILTER

NARROW BAND SHARP CUTTOFF FILTER

ATTENUATES 10KC TO 30 MEGACYCLES

LOW FREQUENCY — LOW PASS FILTER

SUB-OUNCER TOROID FILTERS
Filters employing SUB-OUNCER toroids and special condensers represent the optimum in miniaturized filter performance. The band pass filter shown weighs 6 ounces.

HQA, C, D TOROID COILS
1 1/2" Dia. x 1 1/2" High.

HQB TOROID COIL
2 1/2" L x 1 1/2" W x 2 1/2" H.

UNCASED TOROIDS

VIC VARIABLE INDUCTOR
1 3/4" L x 1 1/4" W x 1 1/2" H.

FOR HIGH Q COILS

HQA

HQB

HQC

HQD

write for catalog PS-520

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Export Division: 13 East 45th Street, New York 16, N.Y.
Cables: "Arlab"

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