AUDIO ENGINEERING

JULY
1952
35c

Gilding the Lily

Up-Dating the Musician's Amplifier. See page 13.

THE WORLD OF SOUND


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AUDIO ENGINEERING

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CONTENTS

JULY, 1952 Vol. 36, No. 7

COVER

Introducing the Audio CaraVan—an audio show on wheels—Electro-Voice's new mobile demonstration unit which will tour the country coast-to-coast. This 38-foot furniture van has been fully equipped with E-V speakers and speaker systems in various cabinets, and for program material the Ampex and Magnecord tape recorders and high-grade phonograph equipment will provide broadcast quality. A built-in switching system will enable visitors to make comparison tests of the various units of equipment. Everyone who visits the CaraVan will receive a 7-inch Columbia record containing excerpts from actual recording sessions conducted by George Szell—shown here in a typical pose. Photos by Electro-Voice and Columbia Records, with the layout from the latter's Art Department.

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

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AUDIO PATENTS

RICHARD H. DORF*

AUTOMATIC NOISE SUPPRESSORS have faded a bit from the public view in the several years since H. H. Scott first introduced the idea on a large scale. Part of the fade has been due to the advent of the comparatively noiseless LP records, and another part has come about because of certain inadequacies of existing noise suppressors—a characteristic "rush" accompanying the change in noise level was one popular complaint, and there are others. A good many people still use them, however, especially a section of the record-listening group which considers the musical quality of the performance the criterion for satisfaction rather than the noise level or audio quality. Such listeners treasure old and scratchy 78's imprisoning immortal performances but radiating sandpaper audio. The dynamic noise suppressor is fine for cutting down the irritation somewhat. It has, of course, other uses, too. Short-wave listeners may find it useful for separating the program from certain types of static, and the same with broadcast listeners in certain areas.

One of the bad features of most suppressors was the fact that the circuit had no way of *knowing* how much noise was present. The idea works on the principle that the response in the noise region (principally the treble) should be kept down until the musical content in the same freqency range is sufficiently higher than the noise level to mask out the noise, at which point response should rise and allow the music to be heard. However, the level of musical content at which response should rise to a given level is dependent entirely on how much noise there is to be masked, and of course that varies from record to record.

The devices therefore had controls for the purpose, and one was supposed to set the controls for each disc by ear and trial, a system which demonstrably fell well short of real satisfaction. With one wrong type of setting, a slight rise in treble content of the music would raise treble response; the noise, unmasked by the music would ride up and down audibly and irritatingly. With another kind of poor setting, so much music content would be required to raise response that the effect was one of an almost permanent low-pass filter, and the highs were never heard except in double-*forte* passages.

All of which is to introduce a noise suppressor invented by John M. Miller, Jr., of Baltimore, which *knows* how much noise there is and sets itself to behave accordingly—to let response rise just when the music will mask the noise, not sooner and not later. The patent, assigned to Bendix Aviation, is No. 2,589,723.

The block diagram of *Fig.* 1 has a good many boxes but looks much more complex than the circuit really is. Output of the pickup, of whatever type, or of the pickup preamplifier, goes to a 600-cps high-pass filter, a voltage amplifier, and a second similar filter. The signal is then rectified and filtered by the 8-cps low-pass filter (this to prevent the action of the device from riding the audio frequencies; it gives a short-period averaging effect). The resulting d.c., negative with respect to ground, is applied to the grid of a reactance tube.

The signal also goes from the pickup or preamplifier direct to the output terminal through a special low-pass filter. This simple two-section filter is not grounded at its "lower" end (it appears upside down in the figure for convenience) but is connected to the reactance tube, whose bias is normally set for a good plate-current flow. Normally, therefore, the tube places a large capacitance between the lower end of the filter and brings its turnover frequency

[*Continued on page 4*]

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

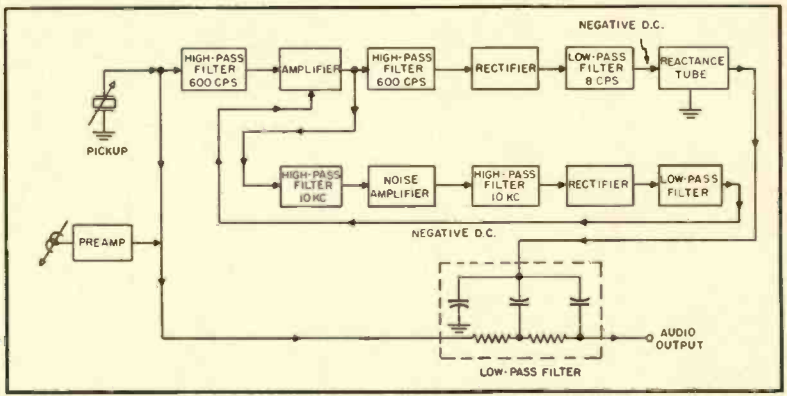

Fig. 1.

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Mr. J. A. Maurer
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37-01 31st Street
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Kindest personal regards,

N. D. Reiss

NDR:rmd
Enc.

N. D. REISS, *(author of the letter at left) of Reiss Public Address Systems, Detroit, shown in action with his Maurer 16mm.*

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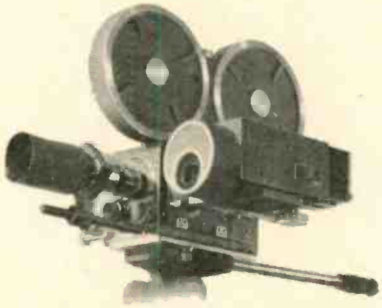

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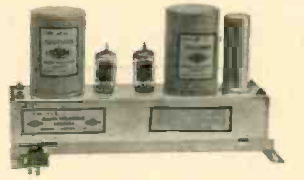

fairly low, so that the pickup signals reaching the output point are substantially only the low-frequency ones.

When high-frequency music—fundamentals or overtones—appears, the highs pass through the upper boxes in the diagram and drive the reactance tube to cutoff, raising the frequency of the series filter to the point where all the usable audio is passed to the output. So far, then, we have a standard-type noise suppressor, which would need a level control in the amplifier appearing between the two 600-cps filters so that suppression level could be adjusted.

Instead of the level control, however, we have a noise detector circuit. This begins with a 10-kc high-pass filter deriving signal from the amplifier output. The audio output of a record above 10 kc ordinarily contains much more noise than signal, and this noise, especially on a shellac disc, gives an indication of how much noise is present throughout the region above 600 to 800 cycles. The noise is amplified, again filtered to assure that little below 10 kc will have any effect on this noise-detection circuit, and rectified. The resulting d.c. is filtered, again to give a short-period averaging effect, and fed back to the grid of the high-frequency amplifier as negative bias.

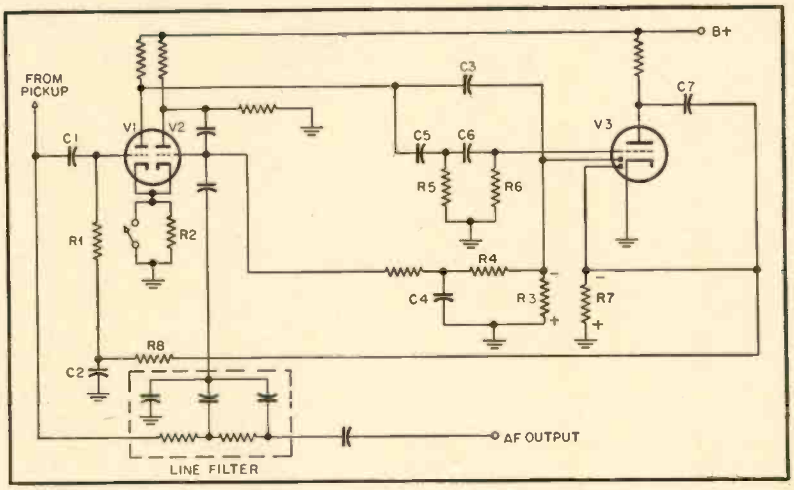

Fig. 2.

Now suppose we have a very quiet record. When treble components of music appear, even at low amplitude, they are sufficient to drive the reactance tube to cutoff, taking the line filter effectively out of action and allowing the highs to reach the output terminal. The noise-detection circuit, detecting little or no noise, does nothing; and the comparatively small amplitude of musical overtones above 10 kc does not operate the noise circuit.

Next we put on a moderately noisy record. As soon as the record starts, the noise content above 10 kc, which is more or less proportional to the noise as a whole, causes negative bias to be applied to the amplifier grid, making the entire section furnishing d.c. to the reactance tube less sensitive. That being the case, it takes a higher level of treble music to drive the reactance tube near cutoff; the line filter therefore stays in action until the music is sufficient to mask the noise even though the term "sufficient" now means a higher level than on the quiet record. On a very noisy record, of course, the reactance-tube section becomes even more insensitive and a still higher-level treble music content is required to make the line circuit pass highs.

In this way, the suppressor tends to control itself, never taking out high-frequency rolloff until the music masks the noise allowed through.

Figure 2 shows a schematic diagram of the circuit which the inventor has designed to do the job. The pickup is fed to the line filter, as in *Fig.* 1, thence to the output terminal. The bottom of the filter is connected to the grid of reactance tube V_2, half of a dual triode.

The signal also goes to the grid of amplifier V_1 through a 600-cps high-pass filter consisting of C_1 and R_1, with C_2 a high-value bypass. Both cathodes of the dual triode are biased to a high value by R_2, which is shorted by the switch when the suppressor action is desired. Plate output of V_1 is taken through C_3 to one of the diode plates of V_3, the rectifier then giving a d.c. voltage across load resistor R_3. R_3 also operates in conjunction with C_3 to form the second 600-cps high-pass filter.

The negative d.c. voltage across R_3 is applied to the grid of reactance tube V_2 through a low-pass filter consisting of R_4 and C_4. Thus the reactance tube is controlled by the signal above 600 cps.

The plate output of V_1 is also applied to the grid of V_3 through a 10-kc high-pass filter C_5–R_5–C_6–R_6. The resulting amplified noise voltage from the plate of V_3 is applied through C_7 to the second diode plate, resulting in d.c. across R_7. Again, C_7 and R_7 make up a high-pass filter at 10 kc. The negative d.c. from this source is applied as bias to the grid of V_1 through isolating resistor R_8 and R_1, causing the amplification of V_1 to be dependent on the noise voltage. R_8 and C_2 also make up a low-pass filter for the noise-voltage d.c.

The total device is, therefore, a 2-tube circuit with not too many components, all of them simply resistors and capacitors. Adjustments should be made with a fairly noisy record with good high-frequency content, adjusting the controls so that the noise does not become very apparent and particularly does not audibly seem to ride up and down with the signal. Once adjusted, further variation should be left to the discretion of the device itself, a practicality which is its outstanding virtue!

Incidentally, the inventor does show, too, an adaptation to take care of low-frequency noise—rumble—and there is probably no reason why a more elaborate version could not suppress both kinds of noise.

Copies of any patents can be had for 25¢ from the Commissioner of Patents, Washington 25, D.C.

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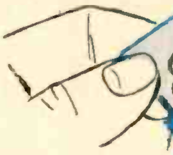

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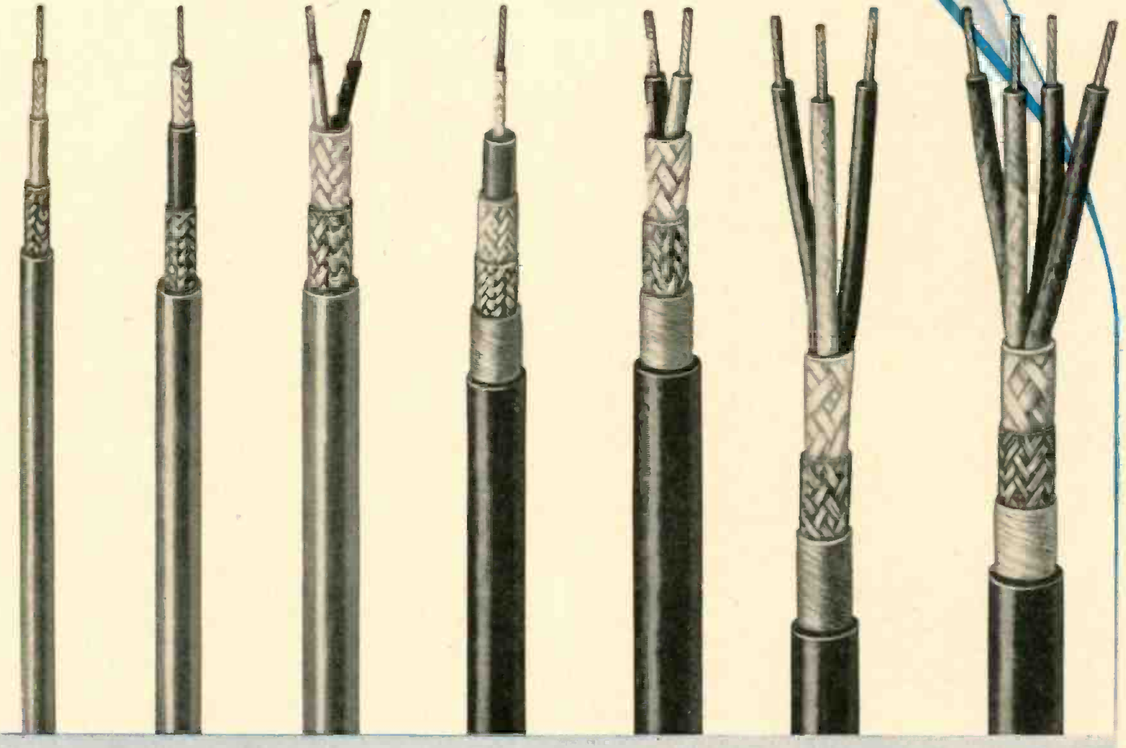

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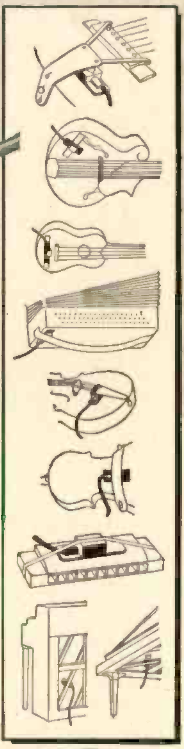

LETTERS

Loudness Control Controversy

Sir:

For two reasons I have demoted my loudness control to a less accessible position in favor of a conventional gain control, these reasons being the highs and the lows.

The LC makes the highs a little screetchy. Pierce of Harvard once explained that when you boost the treble at one point so as to cut it down at another, the odd-order harmonic distortion is not cut down proportionately. For the most part this is not objectionable because the energy is low, but the IRC control seems to push this just over the objectionable point in slightly difficult records.

As for the lows, the further boosting by the LC introduces some unpleasant sounds from the bass reflex cabinet I am using. This muddiness in the bass region may not be noticed immediately unless one switches out the LC, but when this is done, the increased purity of the music is unbelievable.

On the other hand, I miss the control. I seem to be playing the music louder and do not like it. If someone can tell me how to use the IRC LC but avoid the distortion, I would gladly use it once more.

Edward H. Bennett, Jr.,
80 E. Jackson Blvd.,
Chicago 4, Ill.

Sir:

Isn't Mr. Pile the victim of the error common to so many audio enthusiasts who consider the output of an audio system as pure sound rather than as music or intelligence to be conveyed?

In other words, music has a designed balance between the various instruments and voices. In order to reproduce the composer's intentions, this balance must be maintained above all. Unfortunately, few of us have concert halls in our homes or live out in the wilderness where music can be reproduced at its original level. We therefore have to accept the fact that audio reproduction—however faithful—must be a miniature copy of the original. In the dwarfing of the "concert hall" we must take into account the characteristics of the human ear shown in the Fletcher-Munson curves. For example, there is no justification for losing the dramatic tympani introduction of the fourth movement of Beethoven's 5th Symphony because we are listening at a low level.

The argument that an orchestra would sound the same from a distance as equipment without compensation at low level may be true, but it is irrelevant. Beethoven did not expect his listeners to remain in the lobby and I am sure it is the purpose of any composer to let us hear all that is in his score. The loudness control has many faults and at best is a compromise. It is nonetheless a necessary step in the right direction for tonal balance in low-level listening.

George F. Varkonyi,
542 W. 52nd St.,
New York 19, N. Y.

Sir:

. . . All things considered, sound is as subjective a response as are feeling, smelling, tasting, and seeing. The sense of sight is somewhat parallel to that of hearing, since we have for many years known of ways to correct for sight deficiencies and the issue here is the correction of hearing

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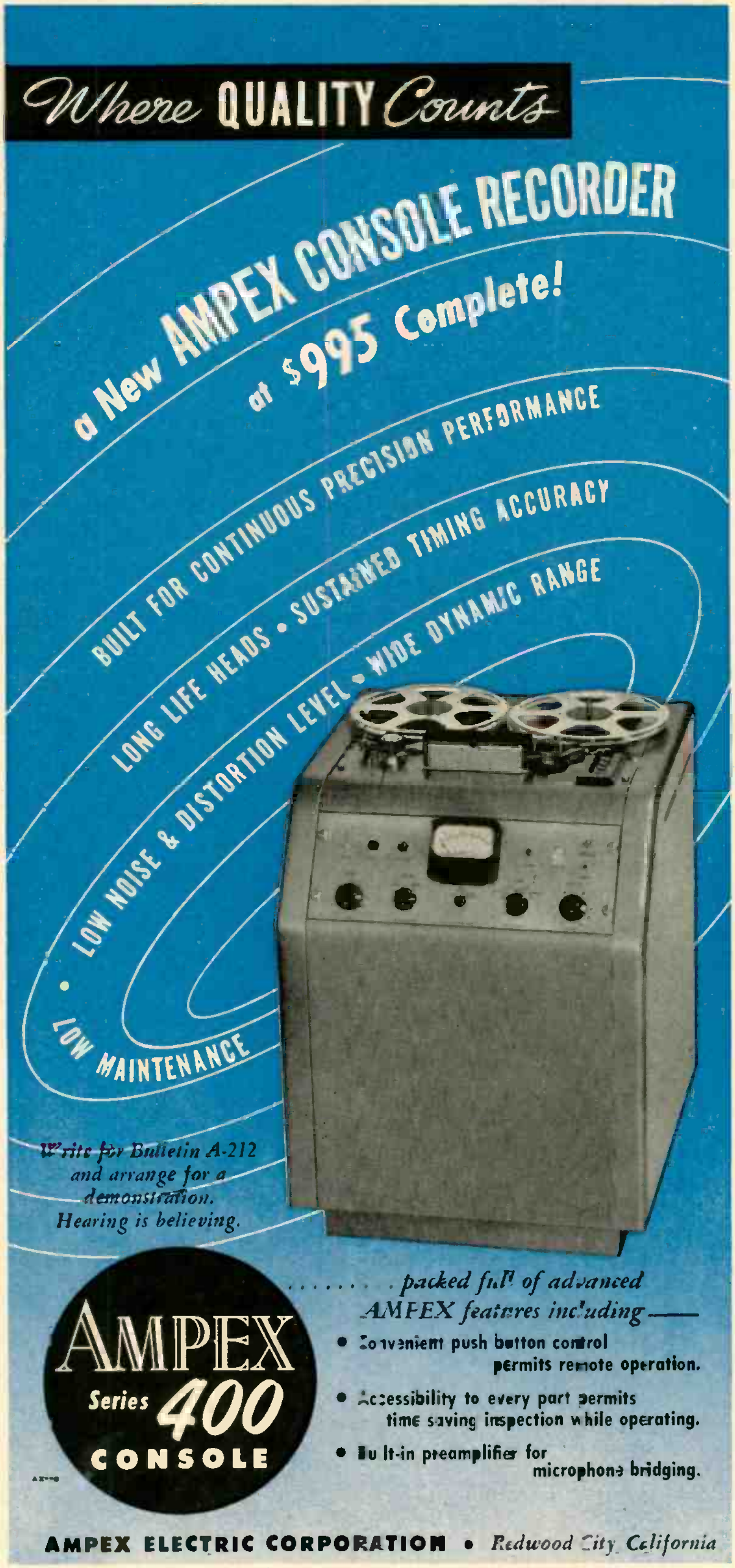

deficiencies. However, when we go to an oculist, he does not hand us a pair of glasses which has been designed to correct for deficiencies which are the average for all eyes, though this is the type of panacea we are handed by the designers and manufacturers of compensated loudness controls.

Even if some of our more progressive manufacturers were to set up studios to which we could proceed to have Fletcher-Munson measurements taken for the purpose of building tailor-made controls, those people who were interested in having their systems sound like juke boxes would still be unhappy. I cannot condemn your viewpoint, because you are genuinely more satisfied with a compensated control than without it. But I find that it is more satisfying to me to adjust my two controls from time to time to suit the prevailing conditions. The only other real solution of which I can think would be to spend all my listening time at live performances.

Howard E. Weinstein,
1606 E. 50th Place,
Chicago 15, Ill.

Sir:

. . . Loudness and tone-control circuits do some weird things to audio signals, particularly where transient response is concerned. A look at a scope screen when pulse, square-wave, and sine-wave-burst signals are fed through them shows them to be "taking off" like a bird. A sweep-frequency generator set up with a fast sweep rate also shows up very poor transient response of such compensating circuits. This results in a non-linear phase effect giving a dirty quality to the highs and a boomy quality to the lows. . . .

Ted Powell,
42 Nassau Road,
Great Neck, New York

(Fortunately we can take 'em or leave 'em, just as we see fit. Ed.)

Ends Static Troubles—Plug

Sir:

Mr. Weil's article in the June issue may well awaken users to the danger of cleaning records by the usual methods, and may improve their reproduction accordingly. However, he failed to mention the part that static plays in attracting dust and lint to the record surface. Paradoxically, rubbing the record at all increases the static charge, as does the friction of the stylus in the groove. What recourse do we have, then? A protective envelope designed to shield the record entirely? An admirable idea, provided the record is never removed from the shield.

Our product—ReKoKleen—is sprayed or wiped on the record surface, cleaning it thoroughly and leaving a mono-molecular film on the disc. It neutralizes any static charge, and prevents any further accumulation of static for an indefinite period. Furthermore, it will work equally well on both shellac and Vinylite without damage to either. We believe many record users will be glad to know of such a product.

Leon Laski,
Record Specialists,
19 W. 27th St.,
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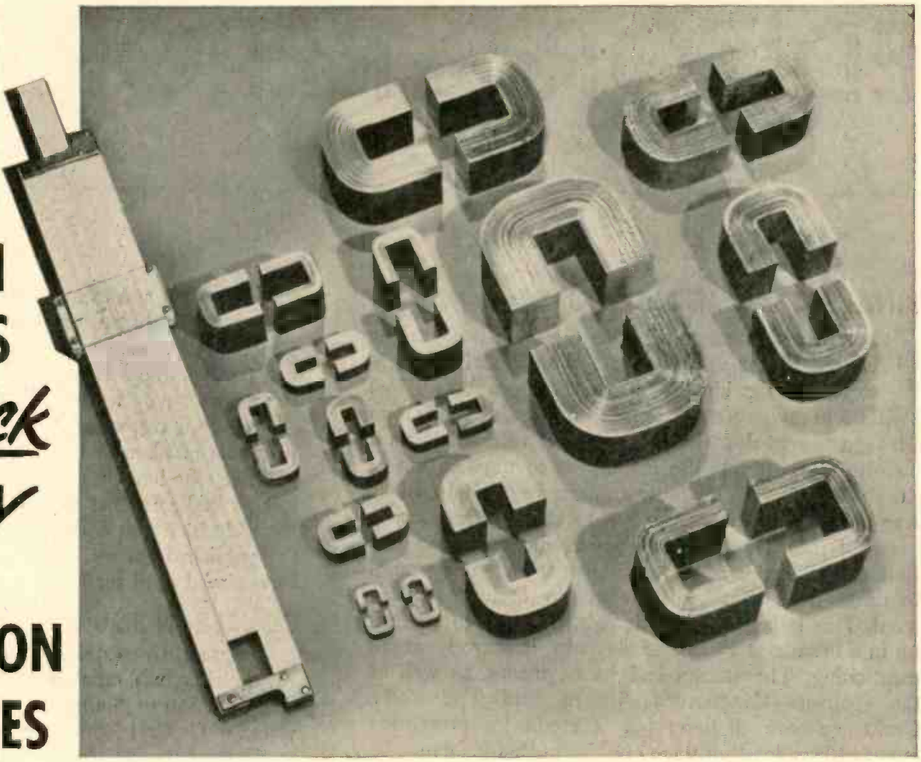

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EDITOR'S REPORT

BINAURAL BROADCASTING

FOR WHAT IS BELIEVED to be the first time in the United States and the first time anywhere commercially, the binaural broadcast from WGN and WGNB to announce the opening of the Audio Fair in Chicago proves that the whole idea is feasible. With a definite indication to the listener as to the location of the instruments in the orchestra, one could feel that he was actually in the studio where the program originated. This listener was slightly confused at first due to the arrangement of the instruments, since it appeared to differ from a standard symphony orchestra placement. This is not unusual, though, for an orchestra set up in a broadcast studio, so the point is scarcely worth mentioning. The station and its engineers, as well as the sponsors—Magnecord, Jensen, and The Radio Craftsmen—are all deserving of credit for presenting binaural broadcasting to the public in this fashion.

Practically on the heels of this debut, KXYZ did practically the same thing on June 7. This Houston, Texas, station arranged two distinct channels, separately miked, and fed them to AM and FM transmitters, using their regular "Saturday at the Shamrock" program for the material.

If this method of simultaneous broadcasting to obtain "Third Dimension Sound," as KXYZ titles it, some means should be developed to equalize the response between the AM and FM channels. As everyone knows, the audio quality from a good FM receiver is superior to that from a conventional AM superheterodyne—although we believe that without static and with certain types of AM receivers, the quality differential is slight. Thus, when the two channels are reproduced by the listener in the correct manner as to speaker placement, the desired effect is a little short of ideal. Should we equalize the AM transmitter to make an effort at having the two channels sound alike, or should the listener use his tone controls to achieve the same effect?

By whatever means may finally become most popular for binaural transmission of radio programs, it seems probable that the idea will catch on and may well become standard before many years. One thing is certain—the enhancement of musical reproduction is exciting, as has already been proven through Magnecord's exhibits of binaural tapes at the various shows.

SMALL SPEAKER CABINET

Considerable publicity has been given during the past month or so to a small speaker enclosure which is said to cover a wide frequency range with comparatively inexpensive components. The basic idea involves the use of four 5-inch speakers—originally similar to those used in the average table model set but specially modified to the designer's specifications—in a triangular cabinet of very modest dimensions but apparently critical construction. We have not, to date, had an opportunity to hear one of these devices in action, and reports from those who have seem to differ.

Measured response curves indicate an output which is flat within about 5 db from 40 to 10,000 cps, but many of those who have heard this speaker system on demonstation indicate that it does not have any apparent "low" bass, which would seem to be in contradiction to the published curves. Final judgment must necessarily be reserved until further information is obtained.

COURSE IN SOUND REPRODUCTION

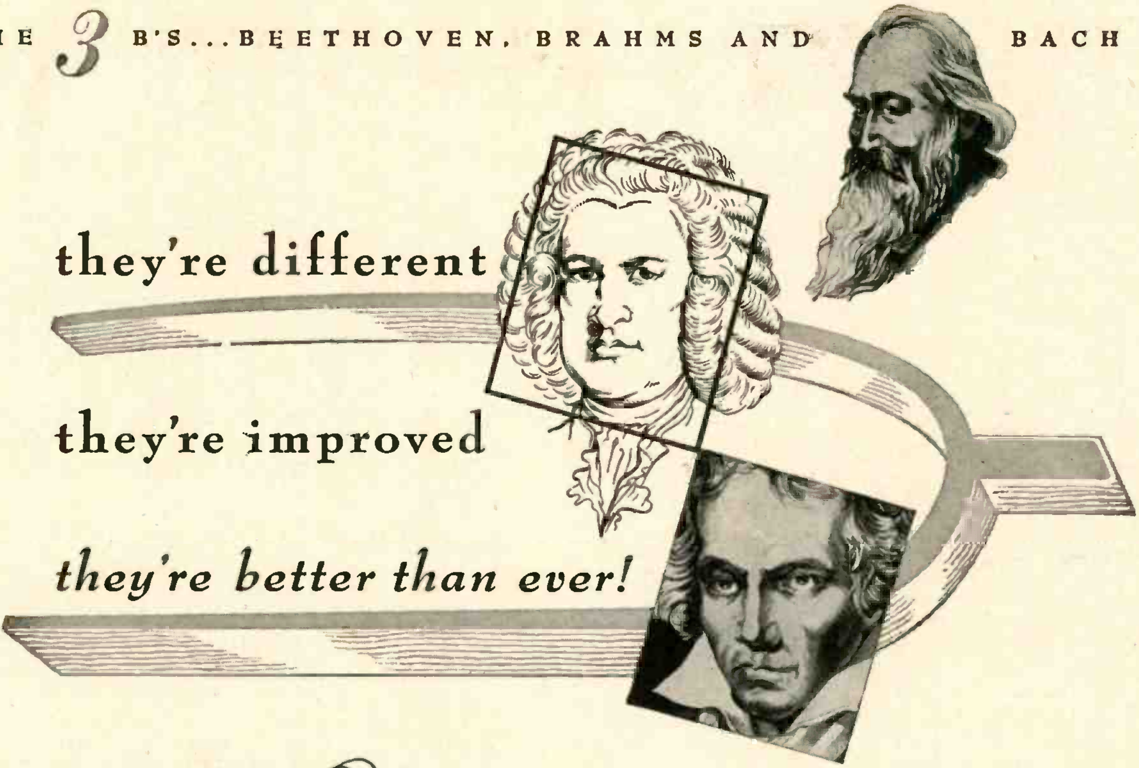
Our recently acquired Contributing Editor, Edgar M. Villchur, will officiate at a course in "High-Fidelity Reproduction of Sound" at New York University, Division of General Education. This course will begin late in September, and classes will be held on Friday evenings at the Washington Square center. Mr. Villchur's course will be given on the level of sound technicians, servicemen, or hobbyists, and will presume some familiarity with the basic elements of electronics, although not that of the engineer. Registration begins September 3rd, and can be done by mail. Further information will appear here in both August and September issues. In general, the course will be similar to the "Handbook of Sound Reproduction" now running serially in Æ.

CALIFORNIA-WEST COAST ISSUE

Following in the footsteps of last August's issue, next month's Æ will be devoted largely to the West—as a tribute to the Western Electronic Show and Convention, to be held in Long Beach, California, August 27–29. Again Æ will be represented on the Coast, and we shall look forward to meeting many of our early associates and still more of our current readers. Audio people seem to be much like fishermen, photographic hobbyists, or any other group that is thoroughly wrapped up in a subject—they like to get together and talk about their hobby. That probably accounts for the enormous increase in interest during the past few years—like chain letters, one audio-minded individual converts others who, in turn, bring still more into the fold.

As we go to press, we are advised by the W & W Distributing Company of Memphis, Tennessee, that they are sponsoring a Mid-South Audio Show at the Peabody Hotel in that city for four days, August 4–7. All types of high-fidelity audio equipment will be on display and demonstration, and the public is welcome. Numerous manufacturers are coöperating, and the sponsor is to be congratulated on his foresight. Hotel reservations for out-of-towners can be made by writing the sponsor directly, at P. O. Box 436, Memphis.

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



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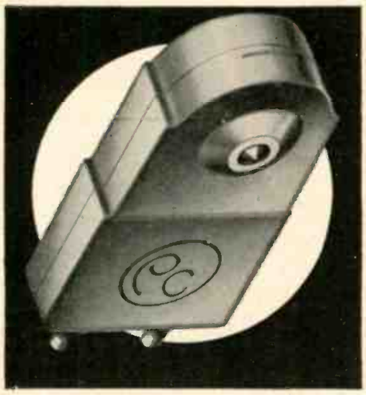

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Oceanside, L. I., New York

In quest of the "skeleton of speech"

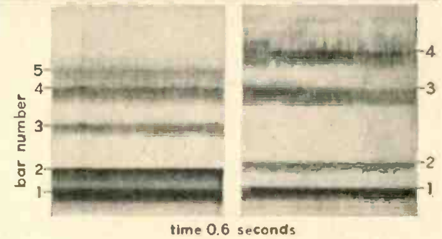
In the famous Quiet Room at Bell Laboratories, this young volunteer records speech for analysis. Scientists seek to isolate the frequencies and intensities which give meaning to words . . . stripping away non-essential parts of word sounds to get the basic "skeleton" of speech.

A child or an adult . . . a man or a woman . . . an American or an Englishman—all speak a certain word. Their voices differ greatly. Yet listeners understand the word at once. What are the common factors in speech which convey this information to the hearer's brain?

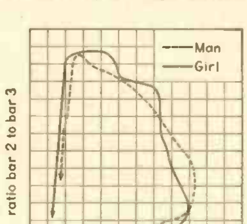
Bell scientists are searching for the key. Once discovered, it could lead to new electrical systems obedient in new ways to the spoken word, saving time and money in telephony.

Chief tool in the research is the sound spectrograph which Bell Telephone Laboratories developed to make speech visible. Many kinds of persons record their voices, each trying to duplicate an electrically produced "model" sound. While their voice patterns are studied, a parallel investigation is made of the way human vocal cords, mouth, nose and throat produce speech.

Thus, scientists at Bell Laboratories dig deeply into the fundamentals of the way people talk, so that tomorrow's telephone system may carry your voice still more efficiently—offering more value, keeping the cost low.



Spectrograms of young girl's voice (right) and man's voice making "uh" sound as in "up." Horizontal bars reveal frequencies in the vocal cavities at which energy is concentrated. The top of the picture is 6000 cycles per second. Pictures show how child's resonance bars are pitched higher than man's.



The word "five." Graph shows ratio of frequency of spectrogram bars. The solid line is for a girl and the dotted line is for a man. Note the similar patterns despite pitch differences. Human hearing extracts the speech sounds from this sort of pattern in the identification of words. Scientists aim at machines that can do the same.

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Gilding The Lily

DAVID SARSER* and MELVIN C. SPRINKLE**

Details of a few simple changes in the Musician's Amplifier to improve performance and listening quality.

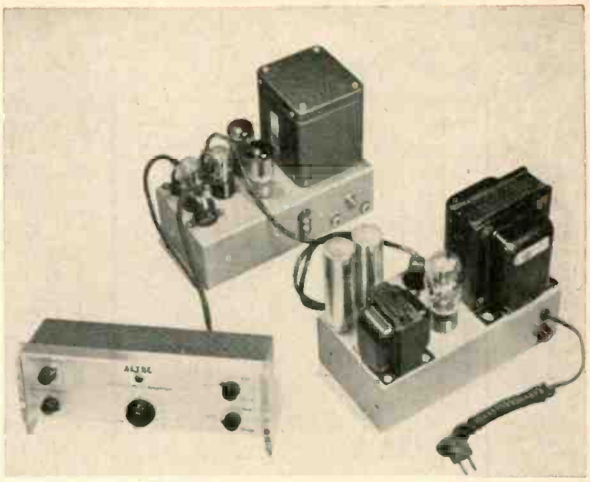

Fig. 1. The converted Musician's amplifier, using the Ultra-Linear connection of the output stage, which employs 5881's instead of the 807's previously specified. The Altec Lansing A-433-A "front end" is shown with the main amplifier and power supply.

The wise man who said that "imitation is the sincerest form of flattery" certainly must have had the Musician's Amplifier in mind. Since its introduction to the American Audio scene[1], the opinions of the authors have been confirmed by literally thousands of audio enthusiasts and engineers who have built them. Further confirmation has been indicated by the many other versions of "The Williamson" amplifier that have appeared both in kit and in wired form. It is conservative to say that no other audio amplifier has ever had such a wide publicity, so many unanimously enthusiastic users, and so many imitators.

As it does to all things, time has brought some changes to the Musician's Amplifier, and it is felt that the authors should bring to the attention of others certain improvements which can be made in the Musician's Amplifier. All of these changes have been field-tested and are recommended to those who have built the amplifier as per the original article. They cannot be made if the original circuit and components were not followed.

Increasing Power Output

Recently there appeared in the literature[2,3] an article which described a power amplifier circuit which is between a tetrode and triode in characteristics and performance. This circuit requires an output transformer which is understood to have a tap at 43 per cent of the turns from center to each plate. Although not shown on the circuit diagram, the output transformer[4] specified in the original Musician's Amplifier article has a center tap in each half of the primary winding, which is at 50 per cent of the winding, not too far from 43 per cent. As the circuit has certain features of interest, we investigated the possibility of using the taps to adapt the Musician's Amplifier and improve its performance. An amplifier was built with an A-B switch, arranged so that in one position the circuit was the conventional Musician's while in the other position the screens were connected to the center taps of each half primary. The results were checked on an intermodulation analyzer and proved to be encouraging. At low powers, say up to 7 watts, there is no difference in distortion, both being under 1 per cent IM and most of the way both are way under 0.5 per cent. Above 7 watts, the Musician's Amplifier begins to have increasing amounts of IM reaching 8 per cent at 12 watts. At this power the tapped connection amplifier is still under 1 per cent, and its IM distortion does not begin to climb until the power output is 16 watts reaching 8 per cent at 19 watts. These results are summarized in *Figs.* 2 and 3. It must be emphasized that the above power figures are those as read on the IM meter and are not equivalent sine-wave power. If the figures are converted to equivalent sine-wave power by multiplying by the factor 1.47,[5] then the power output at 8 per cent is 27.9 watts, while the equivalent sine wave power at 1.5 per cent IM is 22 watts. Effectively, the power output has been increased to 158 per cent of its previous value. This is certainly a worthwhile improvement—particularly when it costs no more than two pieces of wire and eliminates the two 100-ohm resistors which tie the screens to the plates.

Operation

Checks were made on the effect of the change on the plate and screen currents and on dissipation at both full-signal and quiescent conditions. It was found that the tubes were operating within ratings so that satisfactory tube life may be expected. Checks also were made on the response, square-wave performance, and source impedance; these were found to be affected very little. One item of importance was found: as originally described, the circuit is very nearly Class A and the power amplifier is operated toward the upper regions of plate dissipation ratings, but well within ratings. The bias on the final stage was increased so as to go toward Class AB operation. It was found that any move toward higher bias caused the IM distortion to climb, even at relatively low power levels. The original bias resistor of 250 ohms gives optimum results with the new connection.

By going to the tapped connection for the screens, the gain of the amplifier without feedback is increased by about 4 db. With a 4700-ohm resistor supplying feedback voltage from the 16-ohm output connection, the gain increase by using the taps is around 0.5 db or less. Thus the amount of feedback is increased to around 24 db. With most of the amplifiers converted by the authors, there is no tendency toward instability either at sub-audible or supersonic frequencies. Depending on the capacitance and condition of decoupling capacitors, it is possible that a tendency of the loudspeaker to "breathe" or oscillate slowly at 1 cps or less may be encountered. It is recommended that when the change to tapped operation is made, the feedback resistor be increased to 6800 ohms. This value will provide 20 db of feedback, and tests have shown that no appreciable increase in distortion results. For other secondary connections, the feedback resistor may be figured as 1700 times the square root of the nominal secondary impedance.

One of the most interesting and important features of the Musician's Amplifier is the way in which it overloads. Sine-wave power output tests can be made conveniently, quickly, and more accurately than might be supposed, by feeding in a sine-wave signal and increasing the input level until the waveform of the output as seen on a cathode ray oscilloscope begins to clip at the tops and bottoms, or begins to get "bumps" on the sides at low frequencies. The original amplifier overloads so

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** *2 Barry Place, Fairlawn, N. J.*

[1] Sarser and Sprinkle, "The Musician's amplifier." Audio Engineering, Nov. 1949.

[2] Hafler and Keroes, "The Ultra-Linear amplifier." (Pat. pending.) Audio Engineering, Nov. 1951.

[3] Hafler and Keroes, "Ultra-Linear operation of the Williamson amplifier." Audio Engineering, June, 1952.

[4] Peerless S-265-Q output transformer.

[5] *Technicana*, Audio Engineering, Sept. 1948, pp. 19 and 47.

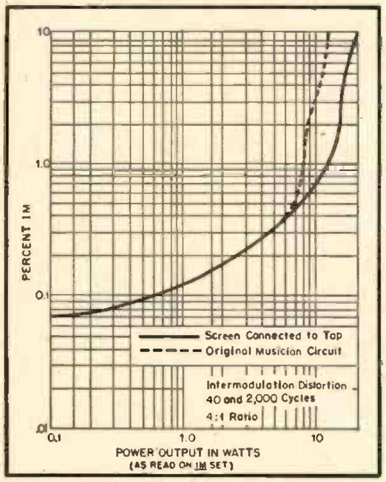

Fig. 2. Intermodulation distortion curves for the original Musician's amplifier (dotted line) and for the converted model (solid line).

smoothly that it is often difficult to tell just when the beginning of overload is reached. Furthermore, when the tops and bottoms of the waves are being clipped, after overload really is evident there is no ringing or fuzz, but only a clean clip. With the change to the screen tap connection, it was found that the overload was just as smooth as with the conventional triode connection.

Some inquiries have been made as to whether or not a large capacitor should be connected across the self-bias resistor of the output stage. It is well known that a large bypass capacitor should be connected across the bias resistor in Class AB stages, as this improves operation at the higher power levels. During the original work, the bypass capacitor was tried and was abandoned because it produced no significant effect. This is because the power amplifier is practically pure Class A. With the tapped arrangement the capacitor was found to have an improving effect at higher power outputs. For maximum power output connect a 50-μf 50-volt capacitor across the bias resistor. However, it can be omitted with the assurance that no noticeable difference will be heard at lower levels.

Listening Tests

Of course the final test of the merits of an audio circuit is now and probably ever shall be the listening test. In music, listening quality is everything. Having an amplifier with an AB switch is an advantage in listening tests, and after considerable listening it is our opinion that the change *does* improve the sound, particularly on fortissimo musical passages when played at concert hall level. At the usual apartment house living room loudness, operation of the switch produces very little noticeable change. Several users tell us that after living with modified Musician's Amplifiers for several weeks, they are convinced that they sound better at all loudness levels.

For those who have built the Musician's Amplifier as originally written up, with the specified output transformer, here are the details for making the conversion:

1. Remove both 100-ohm resistors (R_{22} and R_{23} on the schematic) that tie screens to plates of the output tubes.
2. Connect a wire from the screen of the tube whose plate connects to terminal 1 of the transformer to the adjacent terminal 2.
3. Connect a wire from the screen of the other output tube (its plate connects to terminal 6 of the transformer) to terminal 5.
4. Change the feedback resistor from 4700 ohms to 6800 ohms (or to a value equal to $1700\sqrt{z_{vc}}$ if an output impedance other than 16 ohms is being used).

Output Tubes

In the original paper, the authors used the 807 as an output tube in place of the KT-66 valve used in Williamson's design. At that time the KT-66 was not available in America, although it is now.

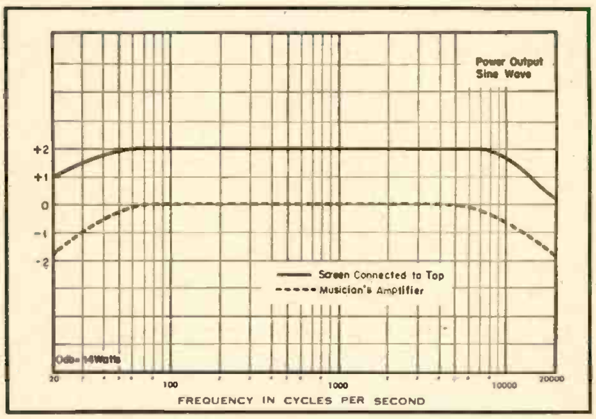

Fig. 3. Power output vs. frequency curves for original and converted amplifiers.

Recently Tung-Sol Electric, Inc. introduced the 5881 tube which is, in effect, a single-ended 807. The total plate and screen dissipation in the triode connection is 26 watts with a plate-to-cathode voltage of 400. It has the further advantage of single-end construction and the now almost standard octal base. The 5881 has been used in the Musician's Amplifier, both in the original model and in those converted to Ultra-Linear operation, and has been found to be very satisfactory from all angles—performance, tube life, cost, and appearance. These tubes are manufactured to a high degree of uniformity, so it is no longer necessary to purchase them in matched pairs. The ruggedized construction minimizes changes in element spacing—and the consequent changes in characteristics—with heating or mechanical vibration. Because of these advantages, the 5881 is now our standard output tube.

Power Supply

There have been several changes in the power supply which warrant a discussion. In the original paper, the editor inserted the words "oil-filled capacitors" in the text material.[6] The accompanying photograph showed round cans in the power supply, and the authors had much correspondence as to where round can oil-filled 8-μf capacitors could be obtained. The answer is simple: the photograph was made with 8-μf electrolytic capacitors. In a number of cases when they could be obtained at reasonable prices, oil-filled capacitors have been used; however, the cans have not always been round. Oil capacitors of 6 or 8-μf. will give a hum-free amplifier. The voltage rating should be at least 600 volts.

The original power supply showed two filter chokes and three filter capacitors. We have found that there is no hum in an amplifier powered from a supply containing only one choke and having two filter capacitors of 6 or 8-μf. The reason for the use of only one choke is to cut down on the d.c. voltage drop in the power supply filter.

Another change in the power supply is in the rectifier tube. The original paper recommended a type 5U4G rectifier. The 5V4G or the older 83V were considered, and their advantage in having a lower internal tube voltage drop was fully recognized, but they were not used because of some past experience with internal tube leakage or shorts. The 5VAG tubes have become readily available because of their wide use in TV receivers as dampers, and it appears that modern construction has made them quite reliable. Thus, we now recommend that the 5V4G be used as a rectifier for improved results. The voltage surge during warmup is practically eliminated with this tube.

With these changes, the output voltage under full load is around 440 volts measured from B plus to ground. With a cathode bias on the output stage of 40 volts, the d.c. plate voltage as measured from plate to cathode on the 5881 tubes is just about 400 volts. With these voltages on the tubes, the cathode current

[*Continued on page 36*]

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[6] We *still* prefer oil-filled capacitors. Most electrolytics rated at 600 volts or more are built-up units using two lower-voltage electrolytics in series. Ed.

Handbook of Sound Reproduction

EDGAR M. VILLCHUR*

A discussion of the characteristics of sound waves which differentiate them from each other—which make a clarinet sound entirely different from a trumpet.

Chapter 2—Factors Determining the Quality of Sound

When we hear a sound we describe the sensation in terms of certain qualities: we think of the loudness, pitch, and tone color, and we are affected by whether the sound is percussive or swells in volume like an organ. These sensations are determined by characteristics of the sound wave, and also by the normal physiological and psychological processes involved in hearing and perceiving the sound. The four characteristics of a sound wave which are primarily associated with the above qualities are, respectively: frequency, amplitude, wave form, and wave envelope.

Frequency

The frequency of a sound is measured in cycles per second, abbreviated as cps. *Fig.* 2-1 shows a modern piano keyboard, with the various frequencies assigned to the keys.

In order to understand the way in which these frequencies are distributed, it is necessary to refer to a subject belonging to the chapter on the perception of sound. There is a general pattern of sensational perception described in psychology by the Weber-Fechner law. This law states that the degree of sensation resulting from a stimulus does not vary directly as the stimulus, but approximately as the logarithm of the unit measuring the stimulus.

$$Sensation = K \log Stimulus$$

This means that when some characteristic of sound is varied over a certain range we perceive a much smaller range of variation than actually exists.

Suppose we were to strike *A* above middle *C* on the piano, 440 cps. A definite sensation of pitch is created. Now we strike the next *A* on the keyboard, 880 cps. The sensation of pitch is that of a note higher by a certain amount. What note must be struck to increase the pitch a second time by the same amount? Even a slight acquaintance with music enables us to answer that question—the next higher *A*. Note the frequency of this last tone; it is 1760 cps, 880 multiplied by two, rather than 880 plus 440.

If the sensation of pitch varied directly with frequency we would have added, for the second equal pitch increase, an increment of frequency equal to the first increment, and we would have sounded a 1320-cps note. But such a note will not increase the pitch as much as the first increase, although the number of cycles added is the same. For a sensation of equal pitch increase we must follow the geometric relationship between 880 and 440, not the arithmetic one.

An equal change in pitch, then, must involve equal *ratios* of frequency, a logarithmic relationship. At the bottom of the keyboard 27.5 cps changes the pitch eight full tones, while towards the top the pitch is changed less than half a tone by the same number of cycles.

The keyboard is divided into parts, called octaves, each with an equal range of pitch. Any note of each octave is half the frequency of the corresponding note of the next octave and double the frequency of the corresponding note of the previous octave. Thus an octave is an interval of frequencies whose highest frequency is double that of its lowest frequency.

It will be seen that the same principle of equal geometric intervals is applied to the construction of scales for frequency response graphs, as illustrated in *Fig.* 2-2.

The Musical Scale

A musical scale is the assignment of frequency relationships, or pitch intervals, to the notes which are used to create melody and harmony. Modern cultures base their scales upon the octave, although the way in which the octave is divided into smaller intervals is not uniform. These intervals are chosen suitable to the music of the time. It is probable that people can learn almost any kind of scale, and come to accept it as natural.

For purposes of melody, any desired scale will work. Scales having more notes, such as those used by some of the Eastern cultures, allow more intricate melodies. Some scales are not suited for harmony, however. This is so because it is the nature of the frequency ratios between two or more notes which determines the harmonious effect of these notes sounded together. Simple ratios such as 2 to 1, 3 to 2, etc., create consonance, while in general the larger the basic numbers involved in the ratio the more discordant the effect. This is usually explained by the fact that many of

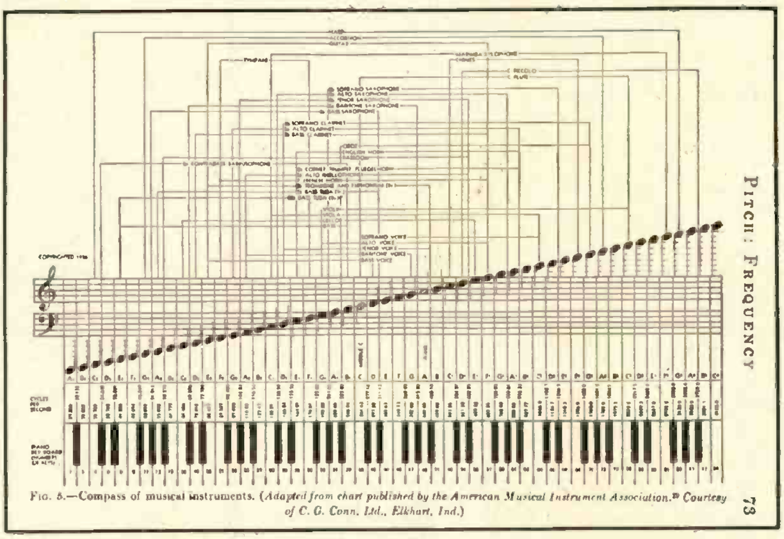

Fig. 2-1. The ranges of musical instruments. (Adapted from a chart published by the American Musical Instrument Association. Courtesy of C. G. Conn, Ltd., Elkhart, Ind.)

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* *Contributing Editor,* AUDIO ENGINEERING.

the various harmonics of two simply-related fundamental tones coincide in frequency, creating a psychological effect of fusion.

During the middle ages the West employed pitch intervals known as "just" or "natural." The frequency ratios between whole notes of a natural scale appear in *Fig.* 2-3. The frequency of each note has an octave relationship with one of the harmonics of *do*.

The harmonies of this scale are pure, as indicated by the integral ratios between notes and by the exact frequency coincidence of certain of their harmonics. Used with an instrument such as the violin, where the performer determines the frequency of any note at will, a composition may be played in any musical key; that is, the intervals of the composition may be based upon the ratio to any single note as starting point (from which note the key takes its identification).

A keyboard instrument does not allow the player to make his own notes, but only to choose predetermined frequencies. When such an instrument is tuned to the natural scale, some musical keys will yield inaccurate melodies and sour harmonies, and so it is not possible to play a composition in any key or to modulate freely from one key to another. Let us take, as an example, an interval of a perfect fifth, which has a frequency ratio of 1½ to 1. On a keyboard tuned as in *Fig.* 2-2, based upon the key of *A*, we strike notes *A* and *E* to produce this dichord. If we were to attempt to play in the key of *B* on the same instrument, and to produce a perfect fifth by striking keys *B* and *F#*, we would find a new frequency ratio between the two notes, that of 40 to 27, or 1.4814 to 1.

Thus the natural scale is only suitable for a keyboard instrument when the number of keys in which the music is written is limited, or when the instrument is able to produce enough different frequencies so that proper intervals may be obtained in any case. This could be done by assigning several different frequencies to the same note, to be chosen from according to the musical key. Such assignments would require that each octave contain 35 notes, an impractical design.[1]

Music which demands the use of many keys, performed upon instruments whose frequency assignments are fixed, needs another sort of scale. The scale in universal western use today is the equally tempered scale, an imperfect copy, from the point of view of harmony, of the natural scale. Temperament refers to the system of pitch intervals, and it is called equal because the octave is divided into twelve half-tone intervals such that the ratio between successive frequencies is always the same, as shown in the chart of *Fig.* 2-4.

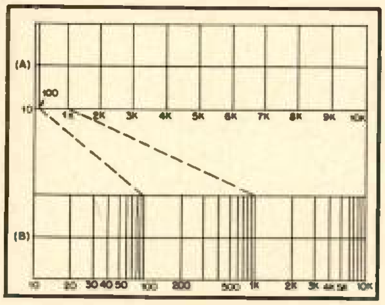

Fig. 2-2. Comparison between linear and logarithmic frequency scales. (A) Linear or arithmetic scale from 10 to 10,000. (B) Logarithmic scale for the same frequency range.

> If the frequency of each note of the octave is multiplied by $\sqrt[12]{2}$ to determine the next higher note, twelve multiplications will give us a final note whose frequency is two times that of the starting note, or an octave higher.
>
> $$(\sqrt[12]{2})^{12} = 2$$
>
> Furthermore, the geometric ratio between all successive notes will be the same, allowing us to start a scale at any point and maintain the same frequency ratios.

The problem of playing in any musical key on a single keyboard instrument is thereby solved. Some time after the proposal of this scale Johann Sebastian Bach, who favored it, wrote a set of preludes and fugues which he called the "Well Tempered Clavier." One prelude and fugue was written for each of the twenty-four major and minor keys, and the entire set was to be played on a single harpsichord or clavichord without re-tuning, a feat which would have been impossible if the strings were tuned to the natural scale.

NOTE		FREQUENCIES, REFERENCE A 440 CPS	NAME OF INTERVAL FROM STARTING POINT	FREQUENCY RATIO FROM STARTING POINT
DO	A	440	UNISON	1:1
RE	B	495	MAJOR TONE	9:8 ($1\frac{1}{8}$:1)
MI	C*	550	MAJOR THIRD	5:4 ($1\frac{1}{4}$:1)
FA	D	$586\frac{2}{3}$	PERFECT FOURTH	4:3 ($1\frac{1}{3}$:1)
SOL	E	660	PERFECT FIFTH	3:2 ($1\frac{1}{2}$:1)
LA	F*	$733\frac{1}{3}$	MAJOR SIXTH	5:3 ($1\frac{2}{3}$:1)
SI	G*	825	MAJOR SEVENTH	15:8 ($1\frac{7}{8}$:1)
DO	A	880	OCTAVE	2:1

Fig. 2-3. Whole-tone frequency intervals in natural or just temperament. The ratios are derived as whole-number relationships to the 1st, 2nd, 3rd, 4th, 5th, 9th, and 15th harmonics of do. The 9th harmonic of do is the 8th harmonic of re; the 5th harmonic of do is the 4th harmonic of mi, etc.

But a certain price is paid for this flexibility. The frequency ratios formed by the musical intervals are a little off from the simple and harmonically related ratios of the natural scale: harmonies are slightly impure.[2] In the natural scale the harmonics of two notes have a common frequency at some point, while equally tempered intervals produce harmonics which have only near-meeting points, off by a small number of cycles. The subsonic differences between the harmonic frequencies create beats and harshness. These discordant effects are more noticeable on instruments which can hold tones at a steady intensity than they are on percussive instruments like the piano. It has been noted that sensitive musicians, when performing upon an instrument where control of exact pitch by breath or touch is possible, often tend to "humor" the note towards its frequency value on the natural scale, and certain violinists and cellists purposely play with natural intervals.

The ratios between the frequencies of different notes are fixed, but the actual frequency assignment for an index note is not governed by any particular principle. 440 cps for the *A* above middle *C* was made an International Standard in 1939, although some conductors and performers—particularly in brass bands—prefer an *A* five and ten cps higher for a more brilliant effect. The modern pitch standard is about half a tone higher than that used in Mozart's day.

The absolute amplitude of sound is measured in terms of pressure, intensity, or power.

> *Pressure* is the force per unit area perpendicular to the path of the wave, exerted by the sound wave on the medium, in dynes/cm² (bars).
>
> *Intensity* is the energy dissipated by the sound wave per unit area, in watts/cm² (joules/sec./cm²).

Intensity takes into consideration not only the pressure exerted by the wave, but also the energy absorbed by the particles of the medium which must be moved by this pressure. For the same medium, either of the above terms may be used to represent amplitude.

Both terms ignore the total area over which the sound is spread. When we know the area "serviced," or are concerned with the total output of the source, we may use the third term:

> *Power* is the total energy dissipated per second, in joules/second (watts). It is equal to the intensity times the perpendicular area through which the sound is radiated.

The Decibel

The range of sound intensities and pressures, and the range of the corres-

---

[1] Use of the natural scale becomes less impractical in electronic organs, which can be designed in such a way as to make possible a shift in frequencies and a switch to a new key. An instrument of this design has been built.

[2] An eloquent defense of natural intervals is made by John Redfield in *Music—A Science and an Art*. Redfield refers humorously to the modern scale as the "tampered" scale.

ponding voltages and power levels in electronic circuits, is very great. For convenience, a system using numbers smaller than the millions and billions involved in the actual numerical ratios would be desirable.

The decibel unit provides us with such a system. A decibel, or db, is a quantity expressing the ratio between two powers, pressures, intensities, etc. or their electrical equivalents. The decibel has no absolute value, and is meaningless unless two values are referred to. It is like the expression "double" or "triple;" an unknown quantity cannot be named as being double unless we know what it is the double of. The decibel unit is also comparable to units of pitch interval such as the octave, whole tone, or etc., which refer to frequency ratios. The difference in frequency between middle *C* and the *E* following might be written numerically, as 68.002 cycles, or it might be expressed in units denoting ratio only, as two whole tones. The latter units, while not tied to any absolute value of frequency, are more convenient due to the smaller numbers used, and have the advantage of being more accurate psychologically.

The Weber-Fechner law applies to the perception of sound amplitude as well as frequency, and so the db unit of amplitude ratio, besides being less unwieldy than absolute numerical values, is also more accurate in relation to human perception. When we say that the intensity of a sound has increased 3 db it means that the intensity has approximately doubled, no matter from .001 to .002 watts/cm^2 or from 1 to 2 watts/cm^2. At a given frequency the db could be considered as an amplitude "interval." Two db represents, under certain conditions, the order of minimum difference of sound intensity that can be perceived by the average person.

The logarithm of the ratio between two powers is expressed in bels:

$$bels = \log_{10} \frac{P_1}{P_2}$$

It will be seen from the above that if a group of power values are arranged on a scale whose fundamental division is for a ratio interval of 10 : 1, *i.e.*:

0.1 1 10 100 1,000 10,000 100,000

each division will be one bel, as the logarithm of the ratio ten is equal to 1.

The decibel, one tenth of a bel, is a more useful unit than the bel. Since it takes 10 decibels to make one bel:

$$db = 10 \log \frac{P_1}{P_2}$$

When the ratios involve, instead of power or intensity, units of pressure, voltage, or current, the equation must be changed. Power varies as the square of any of the above units, a fact expressed by these well known electrical equations:

$$P = I^2Z \text{ or } P = \frac{E^2}{Z}$$

Therefore:

$$\frac{P_1}{P_2} = \frac{I_1^2Z}{I_2^2Z} \text{ or } \frac{E_1^2/Z}{E_2^2/Z}, = \frac{I_1^2}{I_2^2} \text{ or } \frac{E_1^2}{E_2^2}$$

where: I = current
E = voltage
Z = circuit impedance

NOTE		FREQUENCIES, REFERENCE A 440 CPS	NAME OF INTERVAL FROM STARTING POINT	FREQUENCY RATIO FROM STARTING POINT
DO	A	440	UNISON	1:1
RE	B	493.883	MAJOR TONE	1.122462:1
MI	C#	554.365	MAJOR THIRD	1.259921:1
FA	D	587.330	PERFECT FOURTH	1.334830:1
SOL	E	659.255	PERFECT FIFTH	1.498307:1
LA	F#	739.989	MAJOR SIXTH	1.681793:1
SI	G#	830.609	MAJOR SEVENTH	1.887749:1
DO	A	880	OCTAVE	2:1

Fig. 2-4. Whole-tone frequency intervals in equal temperament. Harmonics which ought to coincide miss by a few cycles. Where the fifth harmonic of do should coincide with the fourth harmonic of sol, for example, these two values in the above scale are, respectively, 2200 cps and 2217.46 cps.

Thus when two voltages, currents, pressures, or intensities, appearing in or across the same electrical, acoustical, or mechanical impedance, are compared:

$$db = 10 \log \left[\frac{E_1}{E_2}\right]^2$$
$$= 20 \log \frac{E_1}{E_2}$$

When any of these units are compared as they appear with different impedances, the equation becomes:

$$db = 10 \log \frac{I_1^2Z_1}{I_2^2Z_2} = 10 \log \left[\sqrt{\frac{I_1^2Z_1}{I_2^2Z_2}}\right]^2$$
$$= 20 \log \frac{I_1\sqrt{Z_1}}{I_2\sqrt{Z_2}} = \left[20 \log \frac{I_1}{I_2} + \log \left(\frac{Z_1}{Z_2}\right)^{\frac{1}{2}}\right]$$
$$= 20 \log \frac{I_1}{I_2} + 10 \log \frac{Z_1}{Z_2}$$
$$\text{or } 20 \log \frac{E_1}{E_2} + 10 \log \frac{Z_2}{Z_1}$$

Uses of the Decibel

The decibel unit has a variety of applications. Suppose we wished to know the electrical or acoustical output of a device at different frequencies. We could describe such performance by stating how many db above and below some reference the output varied within a given range of frequencies. We could also plot a graph of relative output in db (by custom, the vertical scale) against frequency. Frequency response graphs calibrated in db, and ratings such as "50 to 15 000 cycles ± 2 db" often appear in audio work.

Another common application of the db units is in expressing the voltage gain of an amplifier stage or succession of stages. The total amplification of a group of stages in cascade, expressed numerically, is the product of all the individual stage gains. Three stages, each with a gain of ten, have a total gain of 10 × 10 × 10, or one thousand. When this amplification is expressed in db, however, the db gain of each stage is *added* to that of the last, and the three stages mentioned above, each having a gain of 20 db, have a total gain of 20 + 20 + 20, or 60 db.

Decibel units are sometimes used to represent absolute power level, by specifying a standard reference level. Since power levels are ordinarily measured by voltmeters, the impedance in which the reference power appears is also stated to make possible the standard calibration of meters in decibels. The two reference levels in common use are:

0 db = 6 milliwatts in 500 ohms.

This level is often used as a reference for calibrating microphones. Example: a microphone with an output rated as – 60 db has an actual power output of .000006 mw. If this microphone were connected across a one megohm input resistor, a voltage of 2.45 millivolts would be produced.

0 dbm = 1 milliwatt in 600 ohms.

This reference level is standard in telephone, broadcast audio, and recording work. Its use is indicated by writing the letter *m* after db, so that the number of dbm is equal to the power level in db above or below 1 mw in 600 ohms.

Other Units of Amplitude

A *transmission unit*, or TU, is another name for decibel. This term is no longer in general use.

The *neper* is almost identical to the db, but based upon Naperian or natural logarithms.

$$nepers = \tfrac{1}{2} \log_e \frac{P_1}{P_2} = .0051\, db.$$

If we attempt to assign a value to the amplitude of any periodically changing quantity, we must determine whether we are referring to the maximum value, the average value, the root mean square (rms) value, or what. The value used most often in sound work and in calibrating a.c. meters is the rms or effective value. This is the equivalent of a steady quantity which would dissipate the same amount of energy per period as the oscillating quantity.

In a pure sine wave the rms value is always 0.707 of the peak value. In complex waves, however, the relationship between rms and peak values is not constant, and rms meter indications are no longer accurate, being dependent—among other things—on the speed of response of the particular meter. When monitoring sound amplitude levels in broadcast or recording work, it is not necessary that absolute effective values be known, but only that meter indications always have some standard relationship to the rms value of non-sinusoidal program material, no matter what brand of meter is used.

A special meter called a volume indicator[3] was designed for this purpose. The main feature of this meter is that its dynamic characteristics—speed of response, overshoot, etc.—conform to a standard accepted in the industry. Other dynamic characteristics might also have served, but the important thing is that all volume indicators are built to the same specifications. These specifications were chosen to provide ease of reading for the monitoring operator.

The meter is calibrated in a unit related to the specific physical design of the movement, the volume unit or VU. This is an electrical unit, but it applies to voltages whose wave form represents audio program material. It is a unit numerically equal to the number of decibels above or below the reference level of 0 VU on the volume indicator scale. This reference level, being intimately associated with the dynamic characteristics of the meter, cannot be defined in terms of power level when complex wave forms are measured. For a sine wave, however, the reference level is equal to 1 milliwatt in 600 ohms, and the VU indication becomes equal to an indication in dbm. The VU is something like a dbm for complex signals.

Two other units—the phon and the loudness unit—involve psychological as well as physical factors, and are defined in the next chapter.

Dynamic Range

Dynamic range refers to the amount of variation of intensity in a series of sounds, from the smallest amplitude to the greatest. A chart of representative sounds, and of their intensities, appears in *Fig.* 2-5.

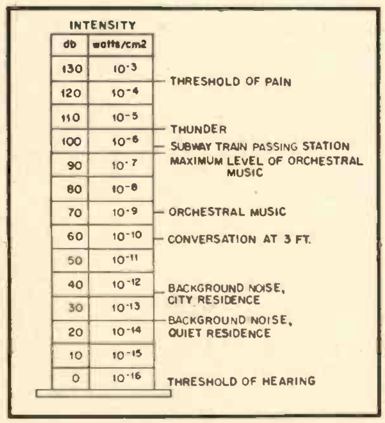

Fig. 2-5. RMS intensity values for various sounds.

Fig. 2-6. Vibrating string clamped at both ends. The dotted lines show the displacement which the fundamental and third harmonic would produce independently. The solid line is the actual displacement caused by both acting together.

Just as the character of a melody depends not only upon the notes used, but also upon the way they are arranged, the character of a musical passage is influenced not only by the intensities present, but also by the range and juxtaposition of intensity levels.

Wave Form

It is very rare that the vibration of a source of sound follows the simple graph of a pure sine wave. The source usually breaks up into sections and vibrates at other frequencies in addition to its primary frequency. These additional frequencies are not random, but are some integral multiple of the primary frequency. They are called *harmonics,* or, in musical terms, overtones.[4] It is the harmonics which give musical sound its characteristic tone color. Without them, the sound wave, beautiful to look at on an oscilloscope screen, has little musical value, as can readily be verified by listening to the pure output of an audio signal generator.

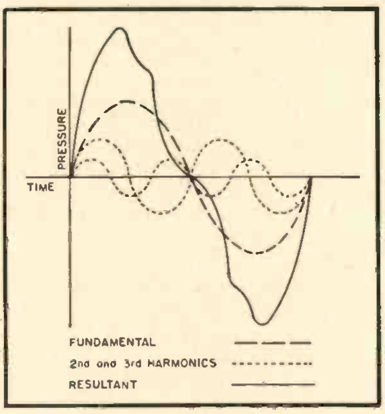

Fig. 2-7. Combination of fundamental and harmonic wave content.

When the string of a harp is drawn back and released, it will vibrate back and forth at its natural frequency, with the greatest swing at the center. This frequency is called the *fundamental* or first harmonic. In addition, the string will act as though it were clamped in the middle, and each half will vibrate independently at the frequency determined by the half length. This secondary vibration produces the second harmonic, at double the fundamental frequency, and the total sound is described as having second-harmonic content. Third, fourth, fifth, etc., harmonics are created when the string also vibrates as though it were clamped at 1/3-length intervals, ¼-length intervals, and so on, as in *Fig.* 2-6.

In spite of the fact that the resultant sound contains more than one frequency, the instantaneous pressure at any one point of the medium can obviously have only one value at a time. No matter what the components of a sound are, contributed by a number of sources and/or by harmonic vibrations, the single-line graph of sound pressure which delineates the wave form contains all elements. *Figure* 2-7 shows how second and third harmonics combine with the fundamental into the resultant wave form.

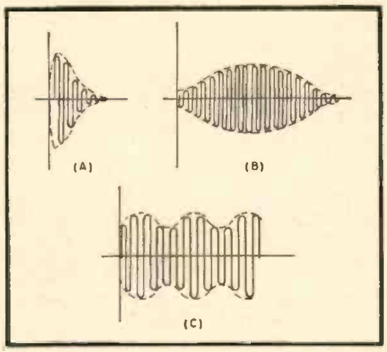

Fig. 2-8. Wave envelopes of (A) percussive sound, (B) sound which swells in volume and dies away, and (C) sound with amplitude vibrato.

Subharmonics—frequencies equal in value to a fraction of the fundamental frequency—are not created by common sources of sound, but do appear in certain mechanical reproducing apparatus. A more detailed discussion of subharmonic generation appears in the chapter on loudspeakers.

Sources may also vibrate at frequencies which are harmonically unrelated to the fundamental. The "clang tone" of the tuning fork when struck is an example of a non-harmonic overtone.

The number, distribution, relative amplitude, and to some extent the phase of harmonics determine the wave form of sound and therefore are for the most part responsible for timbre. (The effect of the phase of harmonics, which is minor, will be discussed in the section on hearing.) The characteristic tone of certain instruments is also influenced by associated noises of bowing, breathing, etc., which make their contribution to the wave form. The erratic vibrations producing this noise are of no predominant frequency; so many harmonically unrelated frequencies are present at once that no definite sensation of pitch is created. There exists only a general impression identifying the band of frequencies covered. Everyday experience

[*Continued on page 40*]

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[3] The volume indicator, or VU meter, is a rectifier instrument having a steady-state calibration, at 1000 cps, to a reference level of 1 mw in 600 ohms. Its dynamic characteristics are such that, with the instantaneous application of a 1000-cps voltage of certain amplitude the pointer reaches 99 per cent deflection in 0.3 seconds ± 10 per cent, and then overshoots the final reading by an amount between 1 and 1.5 per cent. The maximum reading within a specified period of time is taken as the program volume.

[4] The term "overtone" is not quite synnonymous with "harmonic," as it includes all components of a sound higher than the fundamental, whether or not they have an integral frequency relationship to the fundamental.

Planning and Building a Radio Studio

EUGENE F. CORIELL[*]
Major USAF

Part 2. The author continues his series with a discussion of the requirements for sound deadening between studios and between inside and outside of the studio building with practical pointers seldom covered in most construction articles.

In the preceding installment, audio space layout was shown to be dependent upon the programming policies of the station. General principles were given for layout of the studio building as a whole as well as specific studios and control rooms. Emphasis was placed on provision for future growth during original planning and construction, to provide for expanded use of space, and of electrical, ventilating, and heating facilities as well. Acoustics was discussed under two heads—preventing sound leakage into and out of audio spaces, and controlling broadcast sound originating in the studio.

Air Conditioning

Due to the totally-enclosed construction of studios and control rooms to prevent sound leakage, artificial ventilation of some kind is a necessity. Ideally, such a system should have the following characteristics: 1. Change the air often enough for adequate ventilation under expected peak loads. 2. Remove dust and excess moisture from the air. 3. Cool the air in summer (and heat it in winter if desired). 4. Create no noise, vibration, or air hiss. 5. Permit no inter-studio leakage of program sound through ducts between studios. 6. Operate fully automatically on thermostat control. 7. Give positive signal indication of both normal and abnormal operation. 8. Provide 25 per cent overload capacity. 9. Provide for orderly expansion of facilities with station growth.

Small- and medium-sized installations use one or more of the self-contained cabinet type air conditioner. These commonly come in 3-ton and 5-ton sizes, the tonnage referring to their refrigerating capacity. They consist of two main components—a circulating fan with its own motor, and a motor-driven compressor with associated coils and fittings. During summer operation, heat taken out of the cooled air is removed by water circulating through the machine from the building water system. The water consumption is often considerable, and sometimes presents quite a problem in water-short areas. In almost all cases, space is left in the cabinet for an optional steam coil into which steam can be fed from an external boiler. Air forced over the fins of the coil is warmed to provide hot-air heating in winter through the air-conditioning ducts. (Radiators are serious sources of noise and should not be used for studio heating.) Cabinet units are often handsomely finished and are sometimes installed in rooms they serve. However, they are not recommended for installation in the studio proper because, while relatively quiet, their whirr will be picked up by the microphones. They are best located as far as possible from studios, which they should feed through ducts.

The best way to get a first class ventilation system is to have it designed by a professional consultant experienced in broadcast construction. This type of design is complicated, and its satisfactory performance will be in exact proportion to the competence of the man who lays it out. The designer should work closely with the architect, the acoustic consultant, and the station chief engineer to avoid interference between the air-conditioning installation and the placement or use of ceiling lights, studio gear and other building equipment. This is particularly important in regard to location of ceiling air outlets, duct runs, and machinery.

Noise prevention is a major problem in studio ventilating systems. There are three types of such noise. One is the noise created by the blowers, compressors and other machinery. These disturbances may be transmitted through the ductwork, or directly by leakage through walls, or by vibration throughout the structure. Machinery should be located as far as possible from the studios, mounted on vibration insulators, and installed in a sound-proofed room. The rotating elements of the equipment must be carefully adjusted to reduce imbalance vibration, and all electrical and plumbing connections to the units must be through flexible conduit and tubing to minimize transmission of vibration. The ducts should be fastened to the machines

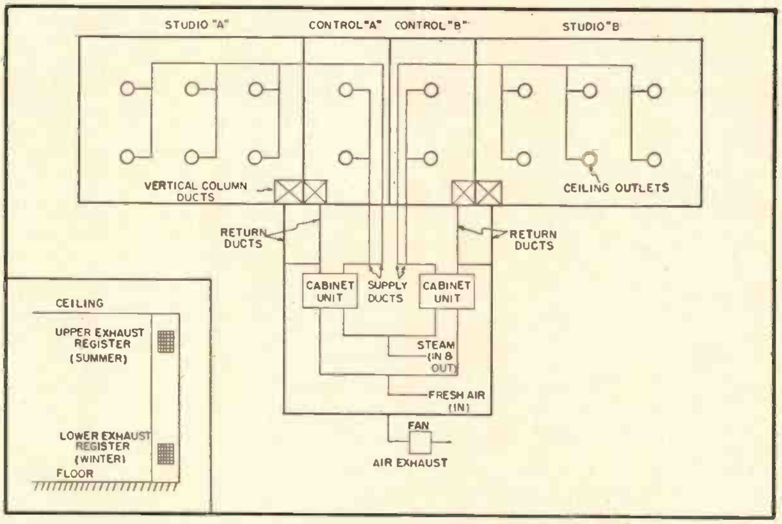

Fig. 1. Air conditioning and heating layout to maintain sound isolation between studios, using separate units and duct systems. Also note that to reduce sound leakage between control room and studio, the control-room ducts are carried back to the units instead of being tied into the much nearer studio ducts. Column duct locations shown were chosen to simplify sketch. Resulting return duct lengths therefore appear shorter in relation to supply ducts than would actually be the case.

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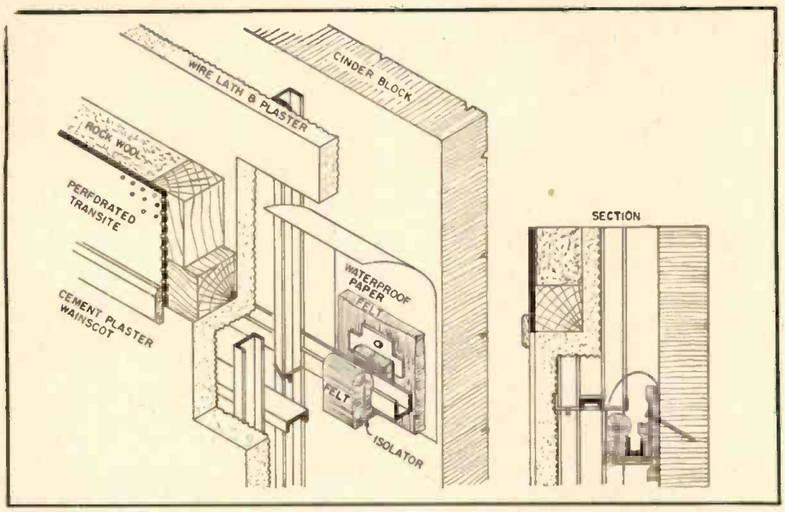


Fig. 2. Commercial wall-isolation system developed by Johns-Manville (Courtesy of National Broadcasting Company).

through flexible canvas collars, for the same reason.

Another noise problem of ventilation systems is that of air hiss at the air outlets. Usual broadcast practice is to specify that air hiss will not add more than three db to the ambient noise level, as measured on either the "A" or "B" scales of a standard sound level meter. One way to do this is to limit the supply duct air velocities to five hundred feet per minute or less. It is important that the type and size of outlet be correct for minimum noise with given velocities, as well as for proper distribution of the air. It is also necessary to line the supply and return ducts with sound-absorbent material. On very long duct runs, lining need not extend the full length of the ducts, but on runs of fifty feet or less between blower and studio outlet, it has been the writer's experience that supply and return ducts should be lined all the way. Ducts should be wrapped on the outside with rockwool blanket covered with heavy paper. All joints in both supply and return ducts should be made by canvas collars, wrapped like the ducts. Also, ducts passing through studio walls should be isolated by such collars on both sides of the wall, and the portion within the wall lined and wrapped as above.

A third noise problem in ventilation systems is that of sound transmission between studios or other rooms through a common duct system. Such ductwork constitutes a negation of the principle of room isolation and may undo the precautions taken to acoustically insulate these rooms. Use of duct lining, exterior wrapping, and canvas collars as described above are helpful in this connection. It is also desirable to have maximum duct length between the tap-offs for any two studios fed from the same main duct, in order that sound from one studio can be attenuated to maximum extent in the duct before reaching the next studio. The same applies to a control room fed from the studio system. The writer has found that for a small number of studios, it is desirable to use a separate cabinet-type air-conditioning unit with its own ductwork for each studio-control room combination, as shown in *Fig.* 1. Note the extra long control room ducts for maximum sound absorption. This design assures maximum acoustic isolation in the ventilation system since the ducts for various studios are tied together only by a common outside make-up air duct and a common exhaust duct, both of these ties being at the machine end of the duct system.

All ventilating systems must be "balanced out." This means that the damper above each ceiling outlet must be adjusted so that for a given fan speed, the outlet will deliver the correct quantity of air in cubic feet per minute. Should this result in too loud an air hiss, the fan speed may have to be reduced, or the system re-balanced, or the size of the ceiling outlet fixture increased. Control of temperature is effected by separate heating and cooling thermostats, located either in one of the rooms served, or in the return (exhaust) duct at the machine end. Ideally, these stats should be coordinated with the outdoor weather through a master stat located outside the building. Since failure of the circulating fan motors may create a very serious problem which may not be noticed until the air becomes bad, there should be a light or other warning signal appearing in an always-manned location to indicate this failure. There should also be a signal to indicate loss of refrigerant gas pressure. Since loss of pressure will automatically stop the compressor through a motor cutout relay, this signal will also indicate loss of cooling action immediately. Other signals should indicate normal fan and cooling action. The operating switches or other controls should be conveniently located, and should be interlocked to make it impossible to start the compressor motor while heating steam is in the system or while the fan motor is off.

It might be well now to consider some of the structural problems of studio construction. One of the most important of these is the walls. As noted in Part I, double walls are preferred over single walls because of their superior isolation for a given weight per square foot. Double cinder-block and double-stud (staggered stud) walls are examples of this type. Both enclose an air space from two to six inches in thickness, and it is extremely important that the physical isolation of the two halves be maintained in spite of the hazards of construction. Any solid contact between the halves will largely destroy their advantage over a single wall. Make every effort to prevent mortar, bricks, and other construction debris from falling between and therefore "bridging" the two halves. A "catchboard" kept just below the workmen as they build the wall will help to prevent this possibility. A final inspection should be made just before the final courses are set and any trash found should be removed. Means of preventing door frames and window frames from bridging double walls are discussed in the sections on doors and windows.

Walls should rise through the false or "hung" ceiling, if any, to the roof or to the floor above, where the joint should be tightly calked. Masonry walls may require reinforcement of the floor. Plaster the wall on both sides. If you plan to paint any acoustic material used, better check with the manufacturer first, or you may find you have painted away your reverberation control. Since acoustic tile and plaster are not particularly rugged, protect the walls with a six-inch base board and a six-inch chair rail. The height of the chair rail should be such that the most frequently-moved equipment—organs, pianos, furniture, sound effects carts, etc.—will strike it when accidentally pushed against the wall. Before leaving the subject of walls, it should be noted that the space requirements and construction problems of double-walls can be reduced by using commercial wall isolation systems such as those developed by Johns-Manville and used by NBC. An example of this design is shown in *Fig.* 2.

Ceilings also present problems in studio construction. A "hung" or false ceiling provides a means of isolating the studio from noises originating on the floor above, and also provides space above the ceiling for conduit, ventilating duct, lights, etc. If there is a story above the studio, the ceiling should be suspended by standard isolation fixtures and techniques. If a suspended ceiling is not feasible, half-inch cork tile laid on the upstairs floor can provide as much as 20 db additional isolation. Carpet can give up to 10 db. If there is no floor above the studio, the false ceiling can be suspended by solid wooden hangers, and at the same time its joists can rest in shallow recesses in the inner halves of the double partition walls. However, it is essential that the joists in any studio stop in their half of the double wall as shown in *Fig.* 3. Failure to observe this precaution will result in joists bridging the wall and largely nullifying its sound isolation value.

The ceiling should be plastered, lined

above with rock-wool sound-isolation blanket, and faced below with specified acoustic material. If flush-mounted Holophane or similar lights are mounted in the ceiling, they should be covered with a sound-proofed cap above the ceiling to prevent sound leakage into the above-the-ceiling space, from whence it may travel to other rooms through masonry cracks, duct work, etc. In the case of ceiling-mounted air outlets, these openings are usually occupied by a diffuser of some type, sometimes called an anemostat. There is almost always a small crack where the diffuser fits into the ceiling hole. This can be sealed with calking compound, and the exposed portion of the diffuser above the ceiling can be covered with rockwool batts.

Floors can be very troublesome in transmitting noise into a studio from adjacent rooms and from the floor below. The latter can be reduced by putting several inches of cinder fill on an existing concrete floor and capping it with a layer of new concrete. This assumes, of course, that the structure can stand the added load or can be reinforced to take it. An alternative is an isolated wood floor laid on sleepers (timbers) resting on isolating supports called chairs. Sometimes the space between the sleepers is filled with rock wool or other sound deadening material to prevent any tendency toward drumming. The new floor should not touch the walls at any point, and the resulting crack at the wall line should be covered by a molding fastened to the wall, but not to the floor. To prevent footsteps and other sounds from adjacent rooms from leaking into the studio through the floor, ¼-inch rubber tile on the original floors of those rooms is sometimes satisfactory if the original floor is a five- or six-inch slab of concrete. It is still better if the concrete is resting solidly on the ground.

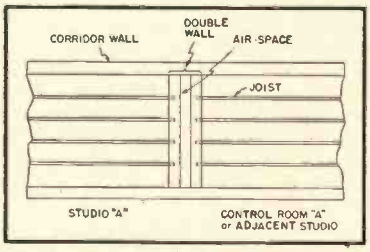


Fig. 3. Plan view of false-ceiling joists for adjacent rooms. Note that joists for each studio or control room end in their respective halves of the double dividing wall, to avoid bridging the wall and reducing its sound-isolation value.

In the writer's experience, no floor covering—except carpet or a sponge-rubber-backed linoleum such as Vinatred—in adjacent rooms will do much to deaden footsteps or other impacts originating in those rooms if the original floor is wood or a thin slab of concrete over a shallow air space, and is continuous with the studio floor. Probably the surest remedy is to lay a new isolated floor in the studio as described above. Not only must the new floor stop short of the walls—it must also be kept from making solid contact with similarly isolated floors in adjacent studios, control rooms, sound locks, and corridors. This is achieved by a heavy felt strip set flush in the crack between the floors to be isolated.

As regards deadening footsteps in the studio where they originate, rubber tile is usually satisfactory on an isolated floor. This is sometimes true of a non-isolated floor if it is heavy enough and stiff enough to prevent diaphragm action. If this is not the case, floor reinforcement and perhaps use of carpet are probably the best answers, although the latter is a nuisance to keep clean.

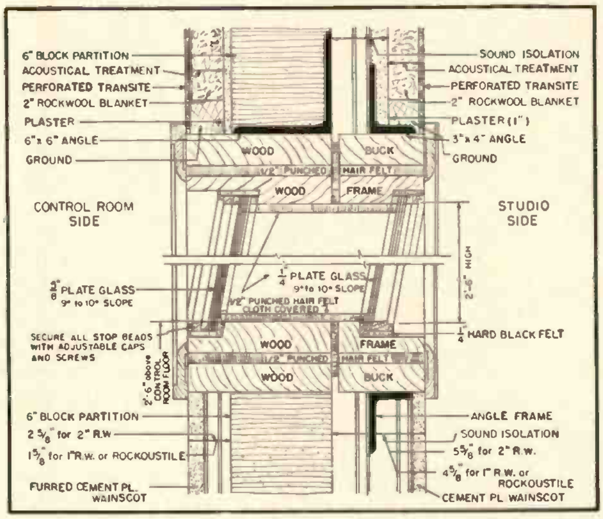


Fig. 4. Sound-insulated control room window. (Courtesy of National Broadcasting Company).

Doors and Windows

Soundproof doors, or more accurately, sound-insulated doors, are certainly required in any well-built studio. These differ from ordinary doors in some or all of the following respects: weight, thickness, internal structure, gasketting and framing, and cost. Such doors range from 100 to 200 pounds in weight, 1¾ to 3 inches in thickness, and for studios, are usually 3 feet wide and 7 feet high. These doors consist of varying amounts and kinds of wood and absorptive material and embody various types of construction to minimize noise transmission. The isolation obtainable from stock models varies from 35 to 43 db, as compared to perhaps 28 db for an ordinary 2½-in. door gasketted as a soundproof door and 22 db without gasketting. The sound-insulated door contains a spring-loaded strip of felt or rubber in a recess at the bottom. When the door is shut, the felt or rubber is forced tightly down against the floor or threshold saddle which must be perfectly flat and square with the frame.

The door frame must also be square and rigidly anchored to support the heavy weight of the door which is generally hung on three hinges. A rubber gasket is fastened at the sides and top of the frame and must be adjusted so that it slightly but uniformly pinches the door. If seasoned wood is not available, a metal frame is preferred. To avoid bridging the double wall with the frame, the latter is made in two halves, one in each half of the wall. Their joint should be isolated by a strip of felt under slight compression and covered by a strip of rubber or by a wooden molding fastened to only one half of the frame. The usual type of heavy-duty door check should be installed at the top, and push plates and door pulls mounted instead of noisy door-knobs.

A door is an acoustic weakness in a soundproof wall. An insulated door should offer the same isolation as—but no more than—its wall. Unfortunately, it is easier to build a 50-db wall than a 50-db door. The problem is generally solved by a vestibule or sound lock when space is available. With the lock walls made very dead, two 35-db doors are often satisfactory for a 50-db wall.

Like doors, windows weaken wall isolation and their area should be held to a minimum. They are constructed of two or even three panes of different thicknesses (to prevent all from vibrating at the same frequency) and are set in rubber or felt, as shown in *Fig.* 4. The panes generally have a ten degree slope downward into the control room. By felting the perimeter of the window frame enclosed within the panes and keeping the panes six inches or more apart, the isolation of the window assembly can be increased by 10 db. To prevent the window frame from bridging the wall, the frame is made in two halves, with one half carried in each half of the wall and supporting one pane. A strip of felt should be lightly pinched between the frames. Remember to locate the window at a convenient height for the engineer who must be able to see into the studio over the top of the console. Finally, the inner faces of the panes are not, alas, accessible for cleaning after installation, so have them cleaned well beforehand. And make sure the installer is a broadcast glazier—he's worth the plenty that he costs.

Electrical Work

In considering the electrical work, let's look at the lighting first. Keep away from fluorescent fixtures in studios and

[*Continued on page 34*]

Universal Amplifier for Magnetic Tape Recorder

C. G. McPROUD

Part 3. Constructional data on the amplifier, power supplies, and carrying case for portable use. Because of its small size, this unit requires considerable care in layout and construction to avoid unwanted feedback.

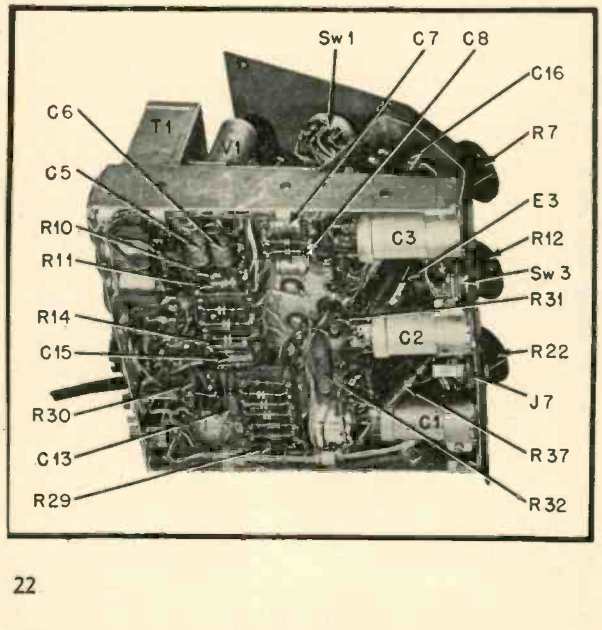
WITH THE DESIGN philosophy covered in the first installment and the circuit operation detailed in the second, there remains only the constructional information to permit the advanced builder to duplicate this unit. While there is nothing especially unusual in the requirement for construction, it must be admitted that the housing originally planned is somewhat small for all the equipment that must be contained.

Chassis Layout and Construction

It is doubtful if anyone who undertakes to duplicate this unit will do so physically, and it is recommended that only the more experienced constructors make any very close attempt to follow the mechanical plans closely. Not that there have been any particularly undesirable features in the operation of the amplifier, but in the fact that the extremely small size is conducive to undesirable capacitances between circuits, and if small shielded wire is used, there is the possibility of introducing excessively large shunt capacitances. Therefore, in addition to describing the construction employed in the original model, a few additional suggestions will be offered which would be followed by the author if the amplifier were to be rebuilt.

Since the external case was already available when this unit was planned, and since it was of a desirable shape and size, the chassis layout was made to fit. It will be noted from *Fig.* 1 at the beginning of the article that the external case is of unusual shape—having a vertical apron on which are mounted the monitor-phone jack and the push-button switch which selects direct or recorded monitoring. Another plane of the front panel is at an angle of 45 deg. to the vertical and provides space for the mixing pots. A third plane at 67½ deg. from the vertical mounts the VU meter, key switches Sw_2 and Sw_4 the two rotary switches Sw_1 and Sw_5, and the recording indicator light E_3. All connections to the circuit are made on the rear apron of the chassis, except for the monitoring phones. *Figure* 9 shows the underside of the chassis, and indicates the chassis construction. The top of the chassis is bent up to meet the panel just back of the two keys, and thence follows the contour of the panel to the bottom. To simplify bending the chassis into this shape, the two sides are separate pieces riveted in place after the top is shaped. The panel is attached to the chassis by means of the mounting nuts on the pots and the jack and switch on the front apron. The two keys are attached directly to the front panel by their own mounting screws, and slots in the chassis top clear these parts.

Figure 10 shows one of the unique features of the construction. The sockets for the three low-level tubes and the cathode follower are mounted on a small aluminum channel which is, in turn, mounted to the chassis by eight soft rubber grommets—four on the channel strip and four on the chassis top—with machine screws through the centers of the grommets. The resistor board (shown in *Fig.* 9) is solidly mounted to the channel strip, and connections made from the tube socket terminals directly to the resistor board with bare wire. All connections to the strip or to the sockets mounted on it are made with very flexible wire to avoid transmitting vibration to the tubes. With the additional mass of the resistor board and resistors mounted on it, the tubes are effectively isolated from any chassis vibration. Sockets for V_4 and V_5 are solidly mounted on the chassis top, and a similar resistor board is mounted



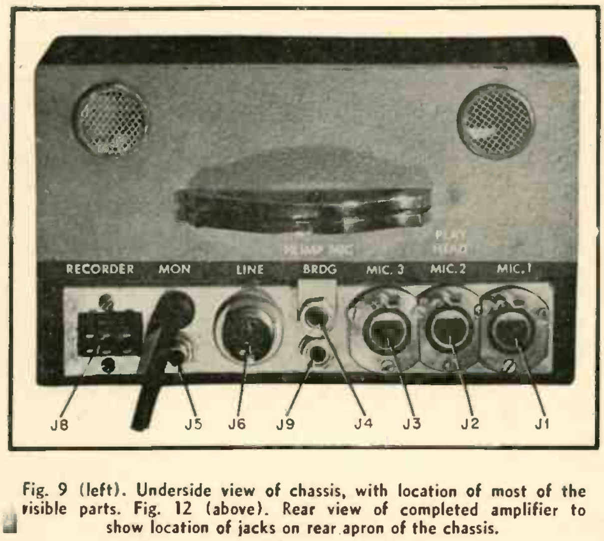


Fig. 9 (left). Underside view of chassis, with location of most of the visible parts. Fig. 12 (above). Rear view of completed amplifier to show location of jacks on rear apron of the chassis.

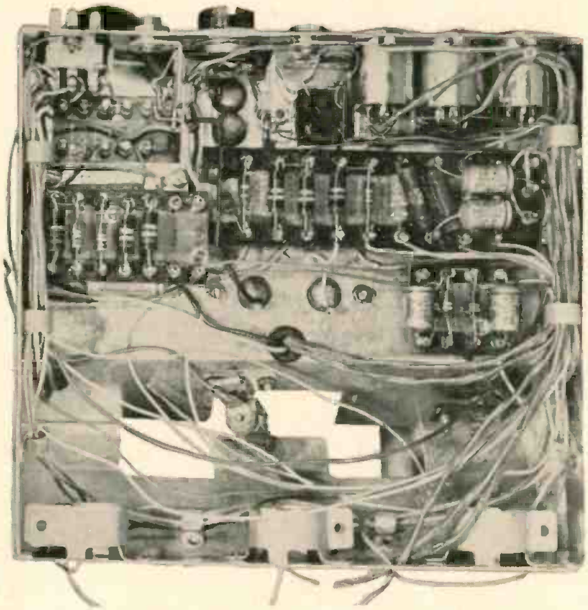


Fig. 10. Bottom view of chassis during construction. Note wiring clips along sides, which aid while building as well as after completion.

directly under these sockets for the associated components.

Perpendicularly mounted on the front apron are three electrolytic capacitors—C_1, C_2, and C_3—directly under the three mixing pots. The input transformers are located along the rear of the chassis, as is the output transformer, for most efficient utilization of space, and to keep the leads between tubes and transformers as short as possible. If this unit were to be re-designed, it is felt that a more suitable arrangement of the pots would be on a bracket below the chassis and nearer to the tubes, with short flexible shafts extending from the pots to the respective knobs.

Study of *Fig.* 10 will provide some indication of the wiring plan. Narrow aluminum strips were riveted to the sides of the chassis to hold the wiring in place, and after completion, these strips were bent around the wires and pressed tightly closed over strips of empire cloth tape to prevent abrasion. All shielded wiring is done with very small leads such as that used for phonograph pickups. The small resistor board at the lower center of *Fig.* 10, mounts C_7, C_8 and the three 0.1-meg resistors in the mixing network. C_9 and C_{12} are visible in *Fig.* 11, as are the three transformers. The locations of most of the other parts are shown on *Fig.* 9.

The rear of the case with the chassis in place is shown in *Fig.* 12. The two ventilating openings are considered desirable, and the handle is provided to facilitate removing the amplifier from its portable case, shown in *Fig.* 1. Note that the three Cannon receptacles, J_1, J_2, and J_3, have been trimmed to permit more compact mounting. The rear of the chassis is held firmly in the case by the bracket extending down over the jack, J_4.

Patching Facilities

Mention was made of the use of this unit for adding reverberation to a recorded program. To do this requires the use of a special patch cord, shown schematically in *Fig.* 13. This cord is inserted into jacks J_5 and J_4, with the plug which goes into J_5 being filed flat on the side which contacts the spring of the jack. This must be done carefully, so that contact is still made with the jack spring, yet without breaking the circuit through the normal contact. For ideal results, it is probable that this cord should have attenuation, without frequency discrimination. It was found, however, that a more realistic effect was obtained with the patch cord circuit shown. Using 1/2-watt resistors and an Erie Ceramicon for the capacitor, it is possible to construct this network small enough so that it will be completely enclosed in a large metal-shell plug. The tip of the common PL-55 surplus plug may be filed to the required flatness without coming apart.

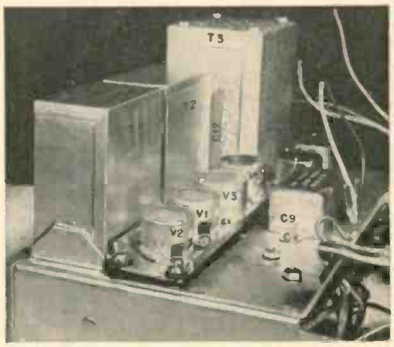


Fig. 11. Sockets for low-level tubes are mounted on a channel strip which is flexibly mounted on the chassis to reduce microphonics.

The jack marked BRDG on *Fig.* 12 was originally intended to connect to the top of R_{12}, for bridging high-impedance circuits, but with this connection it was found that the tube noise resulting from the open transformer primary was objectionable. The spring of this jack is now connected to the arm of Sw_{1d}, and for dubbing from one machine to another, a patch cord—without any built-in network—is connected between J_5 and this new jack, later numbered J_9. A shorting plug for J_6 could be used with

[Continued on page 41]

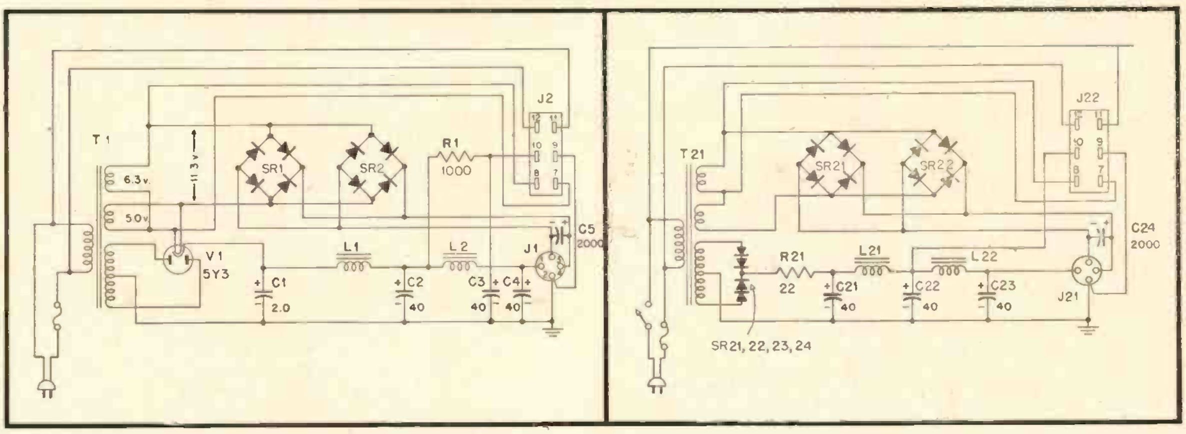


Fig. 15 (left). Schematic of power supply shown in Fig. 14. Fig. 16 (right). Schematic of portable power supply used for field use.

The Audio Fair

PROVING THAT INTEREST in audio is not exclusive to the New York area and the Audio Fairs held there in the Fall, Chicago's audio fraternity turned out *en masse*, as was expected, to the first Audio Fair in Chicago. Held immediately after the annual Radio Parts Show, the Audio Fair provided an opportunity for those in the midwest area to see and hear for themselves just what this is all about. And some 8000 visitors came and saw *and heard*. For two days—May 23 and 24—the fifth and sixth and seventh floors of the Conrad Hilton Hotel were crowded with interested people of all groups—engineers, jobbers, dealers, hobbyists, novices in this field, and those who labeled themselves "just music lovers."

The opening of the Audio Fair in Chicago was heralded on Thursday evening, May 22, with an hour-long broadcast from WGN and WGNB, AM and FM stations respectively, with the first commercial binaural radio transmission. Two microphones and two separate channels throughout recreated the feeling of the originating studio in the upper tower room of the hotel, where the Magnecord-Jensen-Radio Craftsmen-spon-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Selecting Your AMPLIFIER

By

ROBERT NEWCOMB

President, Newcomb Audio Products Co.

There is no such thing as a perfect amplifier. Any given design or system is a series of compromises. Do you select your amplifier from design data or by listening test? Here are some timely tips on how to choose your audio equipment.

THE problem of determining which amplifier to buy has become more and more confusing to the layman in recent years Primarily, this is because the increasingly aggressive advertising on the part of manufacturers and sellers has degenerated to a technical battle as to who can draw the straightest lines on graph paper. Advertisers have exhausted every means to put forth every conceivable technical measurement which might be interpreted as being an advantage for their product. It is natural that advertising men should seek to draw all available data from the engineers. It is unfortunate that most data which the engineer can offer, in any form that is easily publishable, is that obtained from instruments. Since instrument measurements so frequently bear little or no relationship to the resulting sound one hears, it is no wonder that confusion reigns. Not that instrument measurements serve no purpose, for they most definitely *are* important, but they should be considered only as a means to an end—not the end itself. They are particularly valuable to the design engineer during the design of a particular amplifier. His instrument readings have meaning to him only as guides to note variations resulting from changes. The final judge of results *must* inevitably be his ears. Particularly is this so in attempting to compare amplifiers of different design and manufacture. There is no way for one engineer to know the mind of the engineer of another company. Thus, even he cannot always interpret properly the instrument measurements on another's amplifier. Unfortunately, all too often engineers do attempt to evaluate the work of others in terms of measurements on their own products. While such evaluation may occasionally be soundly carried out, in most cases it can only lead to confusion and is meaningless as far as the consumer is concerned, for, all that really matters is "how it sounds." There is absolutely nothing to take the place of the human ear, and, irrespective of the measurements one can make, they simply do not explain the differences one hears between amplifiers. Measurements can indicate electrical changes but they do not necessarily promise that the ear will like the change. The tendency of consumer agencies to report opinions as facts and to quote measurements as complete proof of audio quality can, under these circumstances, do little but add further confusion. Such "recommendations" are undoubtedly made in good faith. It's just simply not possible for another's opinion on sound to be exactly like your own, and it is even more unlikely that response curves quoted as supporting the view can have any practical value to the consumer who must be the one who is to be satisfied. Many a play panned by the critic has been tremendously successful. Many a sound system claimed to be perfect by the engineer has left music lovers absolutely cold. With so many variables affecting the results in a field where musical appreciation and varying tastes simply cannot be adequately evaluated by cold instruments, the potential buyer must accept all advice by well meaning agencies or individuals strictly for what it is—an opinion. Be guided by the company's reputation and experience and perhaps the recommendations of those upon whom you can depend to have knowledge of such matters as regards the construction and dependability. *But,* let no one but yourself determine the resulting tonal quality!

The owner of a custom phonograph installation should realize there is no such thing as perfection and that the best solution to any problem is generally the result of a series of compromises. The variations to be found in the original recording pickup technique, recording process, playback pickup, recording and reproducing amplifiers, the room acoustics for both record and playback, the loudspeaker and its location in the room, the volume level at which the system is played and the individual's ears all combine to produce such variables as to make the final sound one hears far, far different than would be expected by reading published technical data. These are but a few of the many reasons for the potential buyer of a phonograph amplifier to save himself much trouble and just listen to the equipment offered. If he likes it, he should buy it. If he does not like its sound, it simply is no good for him no matter how fine the performance curves may be, or it may be that the associated equipment offered with it is at fault—resulting in an incompatible combination insofar as the individual's taste is concerned. If your system is for record reproduction, use records for your tests.

A discussion of certain features of amplifier design may be helpful to the prospective purchaser. There are so many features offered and so much fine advertising copy that it is well to stop and evaluate them in terms of what is actually accomplished that is of benefit to him. For example: One manufacturer may evolve a splendid circuit which achieves fantastic efficiency (meaning it consumes less power from the power lines in the performance of its job). Such unique efficiency undoubtedly was achieved at higher initial cost which can only be properly evaluated by studying your personal need to reduce power consumption. Most sound equipment draws negligible amounts of power in any event, so further savings here may have little importance to the buyer.

Long arguments can still be started at the drop of a hat on the subject of triode *versus* pentode output systems. Yet, it has been conclusively proven long ago that there need be no actual difference in the results obtainable. Both systems can be equally good, however, it requires much more careful engineering to achieve success with pentodes which may explain why the greatest triode enthusiasts are frequently those who have relatively little equipment and who build only one amplifier now and then. They may simply have had trouble understanding the pentode systems and forever condemn what they will probably never understand. However, pentode amplifiers, as manufactured by top companies and with adequate engineering hours devoted to the original design, can perform as well as triode amplifiers and in some other respects can even surpass designs using triodes. But, as long as satisfactory performance can be obtained using triodes with relatively little work or equipment, home constructors will continue to sing their praises. The buyer of a factory built amplifier, therefore, should not allow himself to become confused by the argument. He should listen and buy what he likes regardless of the output system employed. Any audible differences between really good pentode and triode designs are probably due to other amplifier design factors and not the output system itself. In fact, among the best amplifiers offered, the output systems are all good when compared with the program source, pickups, and loudspeakers, thus other features of the amplifier which will assist in overcoming the many variables referred to previously may rightly determine the amplifier's comparative value to the customer.

Volume expanders are also a confusing feature to most purchasers. In the early years of recording, records did not possess adequate volume range. This condition was further exaggerated by the limited dynamic range of early loudspeakers. The buyer has only to realize how many times his records today must actually be reduced in volume on certain loud passages rather than increased, as would be the result with an expander, and he can quickly cope with the most superbly worded advertising copy on expanders. The improvements in recording and loudspeakers today are more than sufficient to meet volume range demands that are acceptable in the home. Its elimination results in less distortion, less service difficulties, and less expense; thus making room for other more audibly worthwhile features to fit today's needs.

Noise and hum are factors generally expressed in terms unfamiliar to the layman. Furthermore, hum and noise vary. Some types are more audible than others, measurements to the contrary. Thus, much time is saved the buyer by just listening to the product and ignoring the advertising. A little hum can be terribly annoying in a quiet room, especially when large and efficient loudspeakers are used.

The amount of audio power to purchase has resulted in much confusion on the part of consumers, because of the wide diversity of opinion among engineers themselves. The fact is that those who claim 10 watts is enough, and those that speak out for higher powers are both correct under certain conditions. The power needed is not so much a function of the volume at which the listener intends to operate the amplifier as it is the tonal results desired. If one is satisfied with harmonic bass emphasis as a substitute for true bass, a relatively small amount of power is all that's needed. The difficulties arise when one attempts to achieve true fundamental bass emphasis without over emphasizing the harmonic bass tones. This takes special curve shapes which incidentally are costly to achieve and the consumption of power for comparable bass volume becomes terrific. Just because one has more power available in no way implies that the amplifier will not work as well at low volume. In fact, the tone curves permissible only when ample power is available can result in superior low level performance. This does not imply that all high powered amplifiers utilize their power to the best advantage by including the best tone controls in their designs. Unfortunately, very few of them make proper use of the power available except to permit greater volume. This has only helped lend weight to those who argue for lower powers. However, those who have used higher power combined with tone curves designed to take advantage of the power available, to achieve what could never safely be accomplished with low power systems, know that, properly designed, a twenty to twenty-five watt amplifier cannot be equaled by a 10 watt design.

Tone controls frequently confuse the layman who may easily conclude that merely having the controls is sufficient. Here again one has only to listen to become quickly convinced that there is more to tone controls than the performance specifications indicate. Tone controls are costly, that is, good ones are. Since they can represent a good portion of the cost of an amplifier, good tone controls are not too common. The mere statement that so much bass boost is available does *not* indicate that the bass tones thus emphasized will be anything like the original tone, nor does it indicate any of the other factors which are important regarding their performance. All that the specifications generally tell one is that the control emphasizes bass by some specified amount. Only your ears can tell whether the emphasis results in excessive harmonic bass tones or retains the original character of the tone while increasing its intensity, and whether an undesirable change of over-all volume occurs when the tone controls are adjusted.

The amount of inverse feedback is another confusing element highly emphasized by advertising copy and frequently treated by engineers, who should know better, on the basis that if "a little feedback is good, more must be better." The layman will do well to leave the amount of feedback used to the manufacturer and determine his acceptance of the product purely by listening to it. Again compromises must be reached between the advantages inverse feedback offers and the disadvantages it brings. Today's loudspeakers were never designed for zero impedance drivers and a point can be easily reached, when increasing the amount of inverse feedback, where these loudspeakers simply do not perform as well. Again the buyer will do well to let his ears be the judge of what pleases him.

Regarding preamplifiers for use with magnetic pickups, the buyer is cautioned that, while there are many excellent separate preamps available to connect to equipment previously purchased, he will be well advised when buying his new amplifier to obtain one with the preamp built in if this feature will be needed. The reason is simply that the buyer can then readily place responsibility for any excess hum or noise and will be assured of full compatibility in every way.

Remote controls, while undoubtedly desirable for some users, must be recognized as substantially increasing the cost for a given performance. In many cases, they can mean higher hum, noise and distortion, poorer response, and greater servicing expense. Yet, they serve a need and the buyer should carefully analyze his needs to be able to evaluate what the remote control can do for him in return for its expense.

In conclusion, it should be emphasized that the best designs are not necessarily the ones that emphasize some one special feature. The best amplifier will most likely be the one whose engineers have understood the complexities and compromises involved in achieving good reproduction in spite of an almost overwhelming number of variables and have intelligently distributed the costs throughout the amplifier so as to achieve a balance of features and performance that will mean the best possible sound under the greatest variety of conditions. Every phase of the design must contribute its share of the results to be obtained. Just as in a chain, an amplifier is no better than its "weakest link." Unless the potential customer bases his purchase on the evidence of his ears, he is in danger of defeating his prime purpose in setting up his custom system—that of achieving a system that really pleases him personally. In the field of custom phono installations, the customer can truly be "King" if he will but realize that the ultimate aim of his system is to satisfy his personal tastes in reproduction. He, and he alone, can determine what is pleasing to him. No cold instruments will ever substitute for his own ears. Just as every phase of an amplifier's design must be most carefully integrated to achieve the finest result, all elements of the complete system must likewise be carefully selected to achieve a balanced system. For the system, too, is no better than its "weakest link." The music lover who selects the products of reputable, well established manufacturers, on the basis of tonal performance from his own actual listening tests, will be repaid many times over for every dollar invested. —30—

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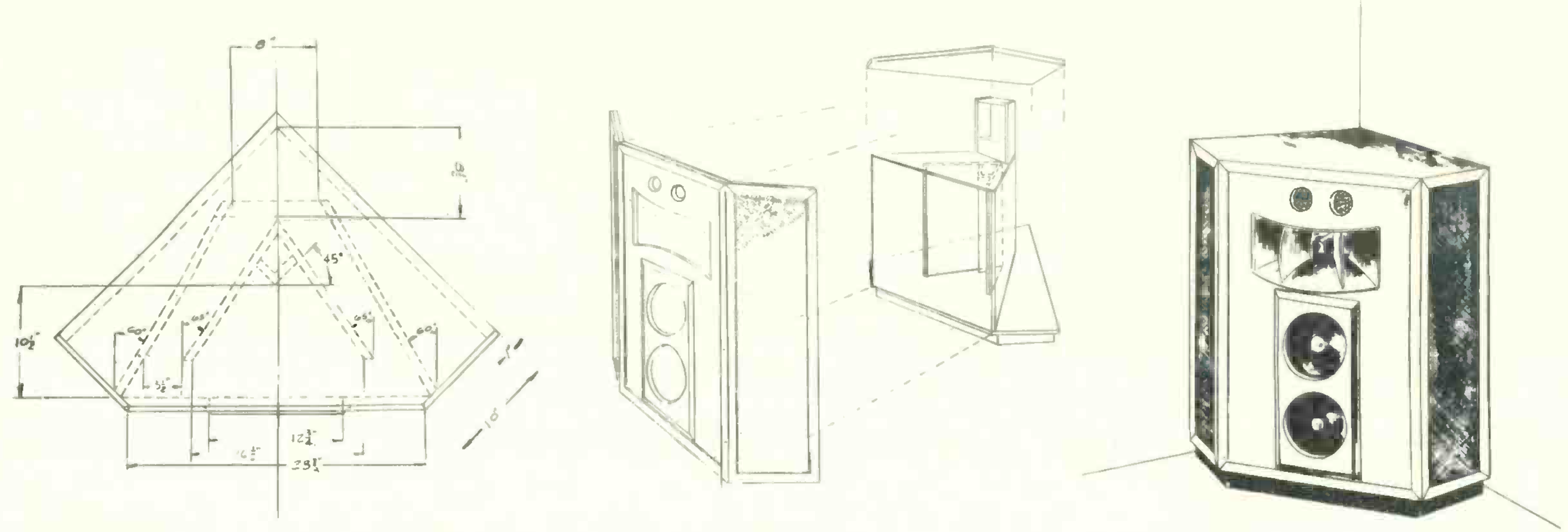

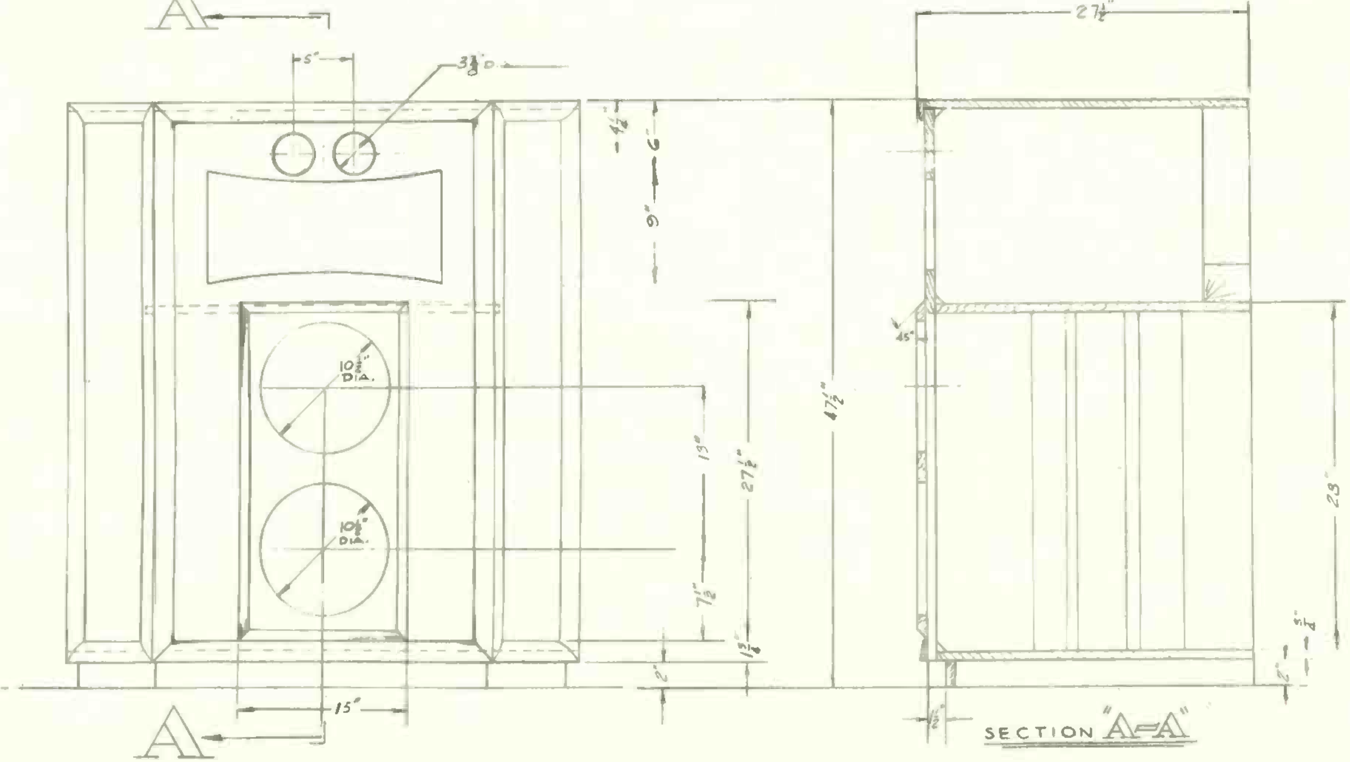

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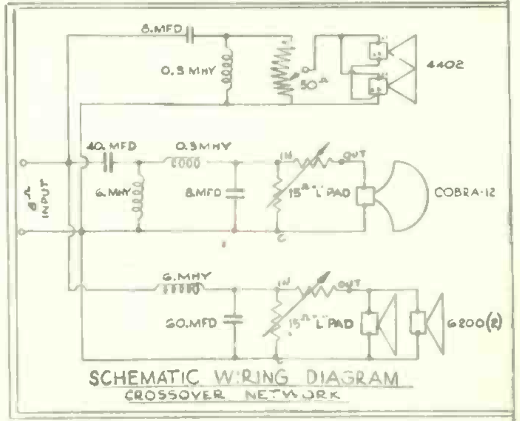


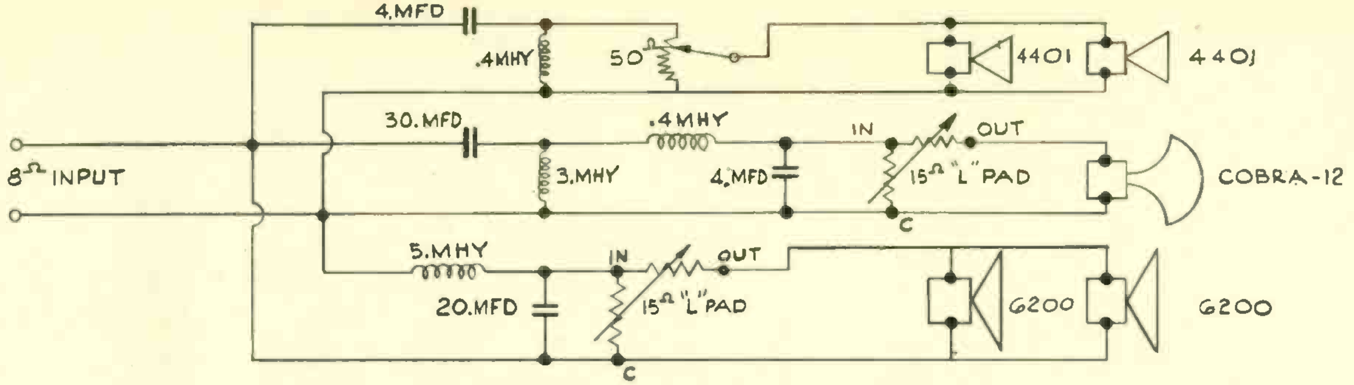
SCHEMATIC WIRING DIAGRAM
CROSSOVER NETWORK

UNIVERSITY LOUDSPEAKERS, INC
WHITE PLAINS, N.Y.

CORNER REFLEX CABINET
(HORN TYPE)

3-WAY SPEAKER SYSTEM
USING (2)-MODEL 6200-(1) MODEL COBRA-12-(1) MODEL-44
MATERIAL-¾ BIRCH OR MAP

ISSUE	REVISION	DATE	APP.



SCHEMATIC WIRING DIAGRAM

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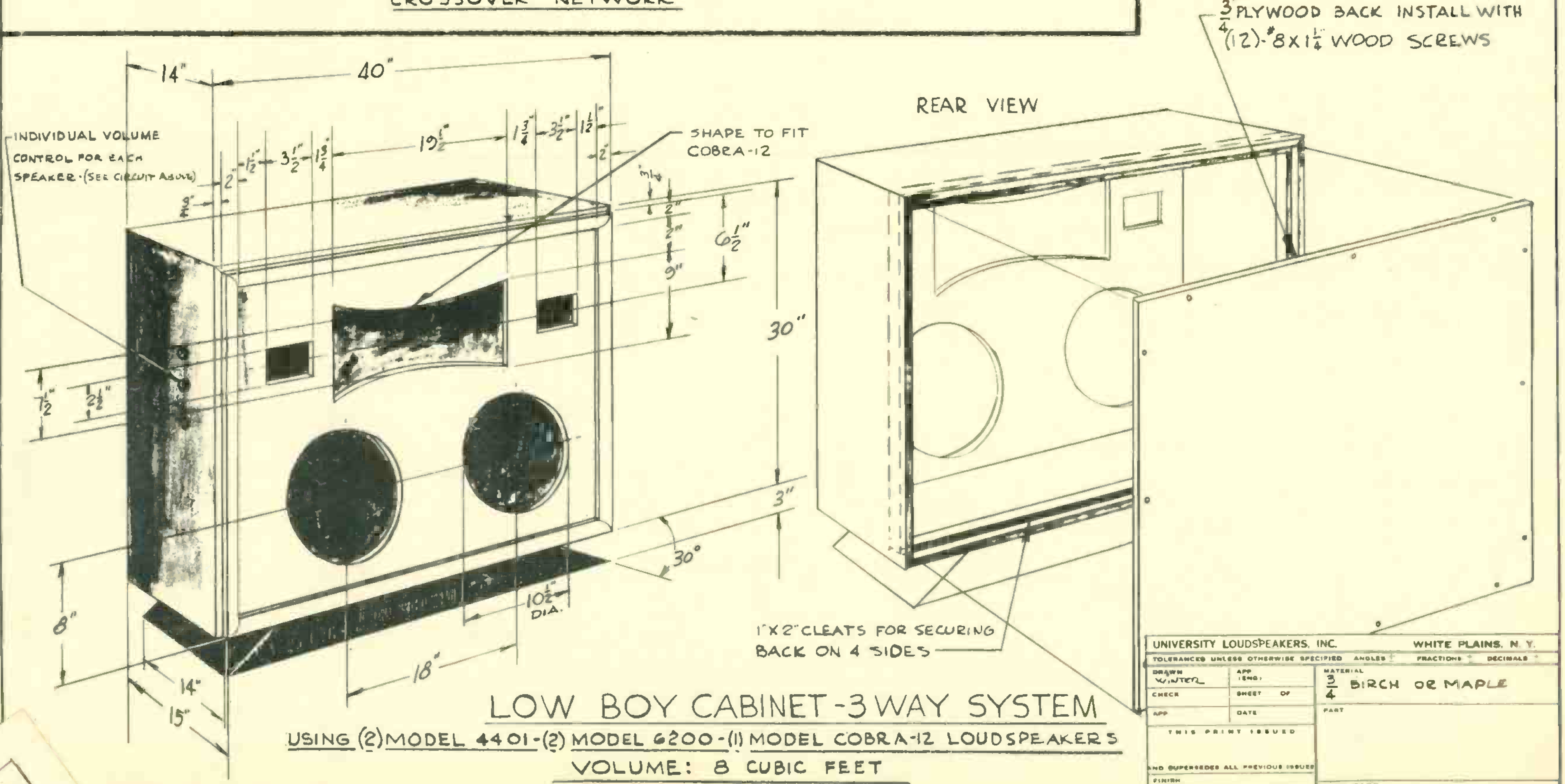

LOW BOY CABINET - 3 WAY SYSTEM

USING (2) MODEL 4401 - (2) MODEL G200 - (1) MODEL COBRA-12 LOUDSPEAKERS

VOLUME: 8 CUBIC FEET

UNIVERSITY LOUDSPEAKERS, INC. WHITE PLAINS, N. Y.

TOLERANCES UNLESS OTHERWISE SPECIFIED ANGLES ± FRACTIONS ± DECIMALS ±

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PART

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in Chicago

sored program was reproduced for the press. Listeners at home were instructed how to place two radio sets at optimum positions to obtain the binaural effect, and from first-hand reports heard the next day, many of them did just as they were told.

To anyone who has ever attended an Audio Fair, the newest one was not particularly unusual. Because of the preceding parts show, exhibitors' rooms were more widely spaced than is usual for the New York Audio Fair, which effectively worked to the advantage of many of the exhibitors who want to demonstrate equipment at levels more closely approximating those which are usual in the living room. To the visitors, it means more walking—much more.

To those who attended the first Audio Fair in Chicago was a revelation; to those in attendance it was just two more days of work. Departing from Æ's usual practice of picturing new equipment, which admittedly is more plentiful in the Fall season, we present the equippers—those who make the equipment which makes the Audio Fairs possible.


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Who's Who in Audio

Caught in various attitudes and occupations—as indicated—were these names and faces well known in the audio industry. From left to right in each photograph are:

(1) H. H. Scott and Victor Pomper of Hermon Hosmer Scott, Inc. (2) E. B. Bohn, of Bohn Organ Co., Ft. Wayne, Ind., subscribes to Æ at booth on 7th floor. (3) John D. Van der Vees and Roger Whitlock of Tung-Sol firm; Harry N. Reizes, Fair Manager and Æ advertising manager. (4) S. L. (Sandy) Cahn, Æ advertising director; Mitchell Cotter of Maynard Electronics; and Stan White of White Sound Inc., with two lovely ornaments. (5) H. S. Morris of Altec Lansing in sales pitch with a customer. (6) David Libsohn and Henry Berlin of Masco Electronic Sales Corp. (7) Howard Souther, Electro-Voice speaker manager; J. Herbert Orr, Irish Tape impressario from Opelika, Alabama; and Larry LeKashman, E-V v-p. (8) Bill Shrader, Æ contributor and Washington, D. C. custom builder; Dick Hastings, West Coast rep; and C. G. McProud, Æ's editor. (9) David Pear of David Bogen, Inc. (10) Walter Eng, design engineer and P. N. Cook, manager, Chicago Transformers. (11) Miryam Simpson and Leonard Werner of Masco, with friend, Miss Freedman. (12) Edward Miller and John Cashman of The Radio Craftsmen, Inc.; guest looking in from left. (13) Tired Herman Kornbrodt of Audio Devices awaits closing hour. (14) Tom de Simone, of RCA Sound Products Division. (15) Gilbert Knoblock, general sales manager of Stancor. (16) Abraham B. Cohen, project engineer for University Loudspeakers, Inc. (17) Frank Hoffman and Eugene Carduner of British Industries Corp. with R-J cabinets in first display of production models. (18) C. G. Barker, of Magnecord, officiates at joint Magnecord-Jensen exhibit in upper tower room. "Reproducer of the Future" occupies elevated stage. (19) Maximilian Weil conducts recorded music concert in comparative quiet, using Audak pickup, of course. (20) Sidney Herbstman of Cabinart, product of G & H Wood Products Co.

(21) Two unidentified Marines enjoy good music played by Weathers Industries' FM pickup. (22) George Silber, of Rek-O-Kut, surprised with customer. Customer is surprised too. (23) Paul Humphreys and Tom Nicholson, both of General Electric, pleased over reception of pickups and speakers. (24) R. C. Martin demonstrates Bell Sound Systems equipment to customer. (25) Heath customer learns about Heathkits from Bill Miller, engineer. (26) Guest learns about new Stromberg-Carlson line from District Manager J. F. Huber. (27) Leon Adelman, Pickering rep, and George Petetin, Pickering assistant sales manager, pleased with interest in pickups and in new audio input system. (28) Oliver Read, Radio & Television News editor with Ernest Clover of Triad Transformers. (29) R. W. Mitchell of Regency, R. A. Morris and F. J. Van Alstyne of Permoflux Corporation. (30) Guest hears new features of Newcomb amplifiers from Robert Newcomb. (31) Milton Sleeper, High Fidelity publisher, Mary Coyle, and Æ's Sandy Cahn. (32) S. L. Baraf and H. Russell, both of United Transformer Co. (33) The two Chesters—Hayes and Snow—of Gray Research and Development Co. (34) Æ's Sandy Cahn, TapeMaster's John S. Margolin, and Vogue Tape Co.'s Milton Berg. (35) R. M. Gray and A. S. Kestor, both of Rauland-Borg, flanking Æ's editor. (36) Pentron's first-aid center comes to the rescue.

An Integrated Line of High Fidelity Equipment

F. H. SLAYMAKER*

First set manufacturer to enter custom component field, Stromberg-Carlson introduces complete line of equipment for the home music system.

APPROXIMATELY 9000 VISITORS to the 1952 Electronic Parts Show saw the premiere presentation of the Stromberg-Carlson "Custom Four Hundred" line of high-fidelity equipment. The line includes an AM-FM tuner, a TV tuner, 10- and 25- watt amplifiers, a record changer, 12- and 15-inch coaxial speakers, a speaker cabinet embodying an exponential acoustical labyrinth, and several other cabinets for housing the equipment. It was shown and demonstrated both to the "trade" and, at the Audio Fair which followed, to the general public.

Stromberg-Carlson decided to enter the high-fidelity field for two reasons. First, the "hobby" of Hi-Fi, not long ago limited to a few hundred enthusiasts, has rapidly increased to a nation-wide trend, numbering its followers in the tens of thousands. Second, the company's experience in audio engineering goes back many years and includes such developments as the Acoustical Labyrinth,[1] the Coaxial Speaker,[2] and early experimental work in FM radio. We are confident, therefore, that we can provide reproducing equipment which measures up to professional standards and yet be in a moderate price range.

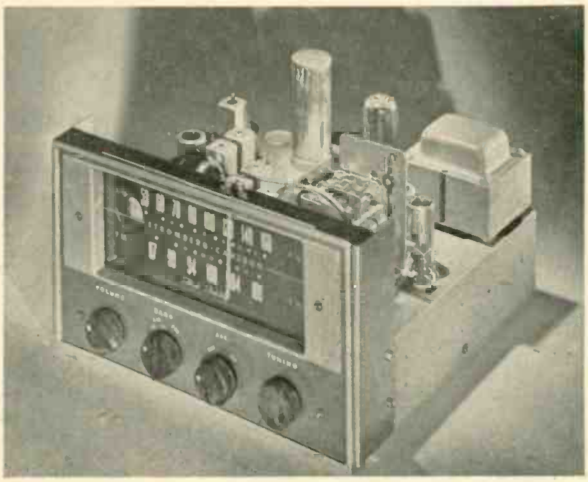

Fig. 1. The SR-401 AM-FM tuner.

The Tuner

Figure 1 shows the AM-FM tuner itself, with the types of controls chosen with the thought in mind that the majority of hi-fi fans are, first of all record fans. The radio tuner, then, is merely one of several possible program sources—one which is very fruitful in some parts of the country but not so fruitful in others. The tuner embodies a minimum of controls, retaining just those which are necessary for the satisfactory operation of the receiver. The only control on the tuner which might be called a tone control is an extra AM position on the band switch which limits the high-frequency response, useful when tuning to distant AM stations. The FM sensitivity of the set is sufficiently high so that adequate quieting is obtained even on marginal stations. Two broad-band intermediate amplifier stages are used on AM to obtain the optimum in audio-frequency response versus adjacent channel selectivity. A.f.c. is incorporated in the FM circuits to make the tuning easier. Often, however, when the user is trying to listen to a weak FM station adjacent in frequency to a strong station, the a.f.c. will pull the set into the strong station, making it virtually impossible to receive the weak one, so a switch is provided to turn off the a.f.c. On AM the frequency response is flat from 20–7000 cps with a sharp dip at 10,000 cps to reduce the intercarrier whistle. On FM the response is flat from 20–20,000 cps.

The Amplifiers

The 25-watt AR-425 amplifier is a two chassis model in which the tone controls, compensated loudness control, and selector switch are mounted in a small remote control chassis which is housed in a mahogany case, as shown in *Fig.* 2. For custom installation where the user desires all of the amplifier equipment to be built in, the remote chassis can be removed from its case and mounted on the panel of the built-in installation.

Fig. 2. The 25-watt amplifier, with its remote control cabinet.

Separate boost-and-cut controls are provided for the bass and treble. In order to minimize the tendency to make the human voices sound "boomy" or "tubby" when the bass boost is turned up, the circuit is designed to raise the level of the extreme low frequencies first without affecting the middle-low frequencies. As the control is turned further, the bass boost control fills in the middle range. Both controls are continuously variable—not step controls. To make low level listening as satisfactory as possible, the volume is controlled by a three-section loudness control that boosts both the bass and the highs as the level is reduced.

In addition to the bass and treble controls, there is a brilliance control which permits the attenuation of the extreme high frequencies without affecting the musical balance of the reproduced music. When a conventional treble control is used for noise reduction, the music begins to sound muffled before sufficient noise reduction is obtained. The sharpness of cutoff in the brilliance control is a function of the frequency of cutoff. The sharpest cutoff occurs in the highest cutoff position, while at lower frequency settings the cutoff becomes more and more rounded. When a filter is used that has a sharp cutoff frequency near the musical range, an unpleasant "ringing" sound is produced that resembles the sound

[*Continued on page 28*]

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* *Chief Engineer, Sound Equipment Division, Stromberg-Carlson Co., Rochester, N. Y.*

[1] Benjamin Olney, "A method of eliminating cabinet resonance, extending low-frequency response and increasing acoustical damping in cabinet-type loudspeakers." *J. Acous. Soc. Am.*, Vol. 8, p. 104, Oct. 1936.

[2] Benjamin Olney, "The coaxial speaker." *Electronics*, Vol. 13, No. 4, p. 32, April 1940.

Sensation in Bass!

EV FOLDED-HORN CORNER ENCLOSURES

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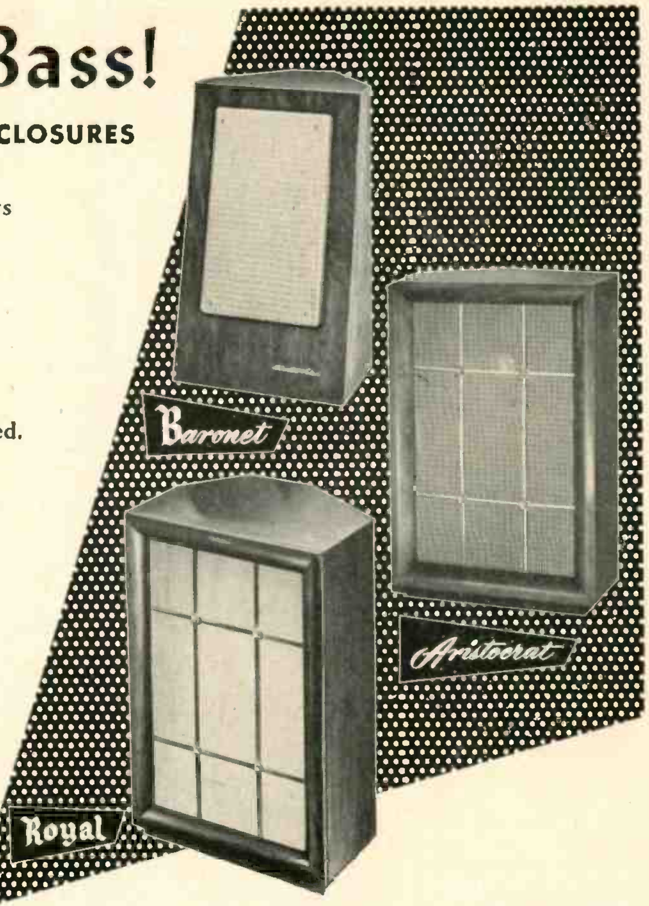

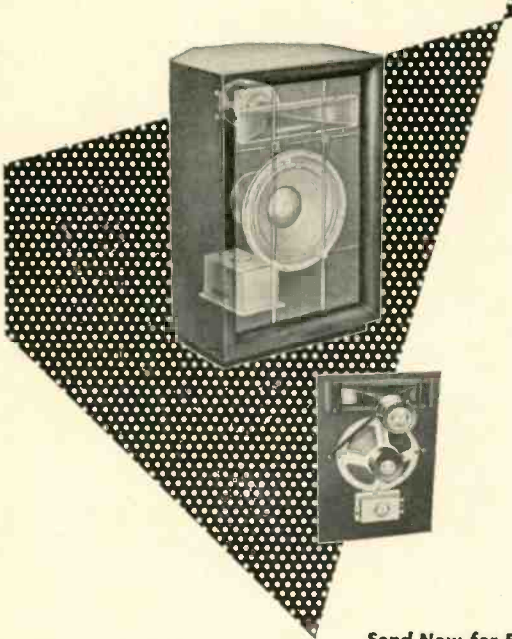

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Model 108 Standard 800 cps Separate 2-Way Speaker System. It consists of 12BW-1 L-F Driver, T-10 H-F Driver, 8-HD Diffraction Horn, X-825-1 Crossover Network, flat baffle board and AK-1 Accessory Kit of mounting hardware. 27" high, 18" wide, 12½" deep.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

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

Model 114 Super 800 cps Separate 2-Way Speaker System. Consists of 15-W-1 L-F Driver, T-25 H-F Driver, 8-HD Diffraction Horn, X-8-1 Crossover Network, AK-1 Accessory Kit of mounting hardware, and flat baffle board. 33⅜" high, 22¼" wide, 13½" deep.
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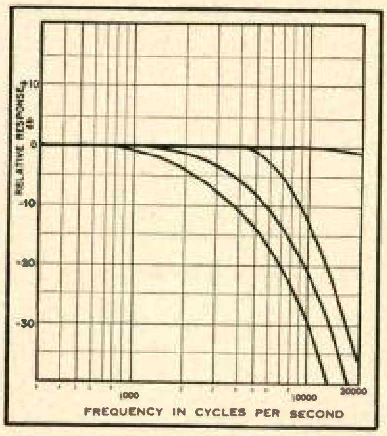

Fig. 3. Frequency-response curves showing the action of the Brilliance Control on the 25-watt amplifier.

of a response peak in the high-frequency region. By rounding off the "corner" of the cutoff characteristic, this ringing can be prevented. *Figure* 3 shows the frequency-response curves for the brilliance control and the manner in which the shape of the cutoff characteristic is altered as the cutoff approaches the range, below 4000 cps, where the fundamentals of the higher musical instruments can be affected.

Four different playback curves are provided for the phonograph inputs. There are two foreign recording curves with a 250-cps turnover. One curve reproduces the highs flat, and the other provides high frequency de-emphasis to match the pre-emphasis used in the FFRR curve. Two American recording characteristic curves are included—the AES curve and the LP curve. For the listener who wishes to reproduce, exactly, the signal that was fed into the terminals of the monitoring speaker in the recording studios, these different equalizations are of vital importance. Probably, however, many listeners will find that their own taste in orchestral balance does not agree with the taste of the recording engineer. It may sound like heresy, but many listeners use the record equalization settings as an additional tone control to achieve the tonal effects wanted.

Input connections and switch positions are provided for a magnetic pickup either high or low level, a high- or low-level radio tuner, a high-impedance low-level microphone, and an auxiliary position which can be used for the output from a tape recorder, TV tuner, crystal pickup, or other program source. The output transformer is large in order to provide full power output at the extreme low-frequency end of the spectrum. Pipe organ fans, especially, want the full power, low distortion bass reproduction that can only be obtained with a large output transformer.

The 10-watt AR-410 amplifier is shown in *Fig*. 4. The results of various thorough surveys of the sound distributors and their customers showed that there was a definite demand for a ten-watt amplifier of high quality and moderate price as well as for the higher-powered model. The AR-410 is a one-chassis amplifier containing the minimum number of controls that can give the listener complete control over the musical balance of treble and bass as well as adequate record equalization curves. The bass, treble, and loudness controls are identical with those used on the AR-425, but the brilliance control has been omitted. Two types of record equalization are included: one which is very close to the NAB, AES, and the LP curves; and another which is similar to the first curve, but having a 250-cps turnover for playing foreign recordings. The small remaining variations in the amount of extra bass boost used in various recording curves and the amount of high frequency pre-emphasis can be compensated satisfactorily by adjusting the treble and bass controls. The input connections are identical with those on the AR-425 except for the mechanical arrangement.

For the convenience of the person who wants to build-in the amplifier, the escutcheon is removable and can be mounted on the outside of a wood panel. Also, in tricky installations where it is not possible to mount the amplifier directly behind the panel, flexible shafts are available to connect the controls to the knobs on the panel. The output transformer is sufficiently large so full power can be obtained at the lowest frequency which the amplifier will reproduce.

Loudspeakers

Two coaxial loudspeakers are included in the "Custom Four Hundred" line. The RF-471 is a 12-in. direct-radiator coaxial speaker and is quite similar in many ways to the first coaxial speaker which Stromberg-Carlson introduced in 1940. The actual cone in the direct radiator tweeter is only 2 inches in diameter to insure a wide angular distribution of the high frequencies and smoother response than can be obtained from a larger tweeter. The edge reflection, which is likely to introduce violent peaks and dips in the high frequency region, is eliminated by the Carpincho leather surround.

Fig. 4. The self-contained 10-watt amplifier.

The RF-475 is a high efficiency, 15-in. coaxial speaker that is completely new in the Stromberg-Carlson loudspeaker line. To obtain as high flux densities in the gap as can be obtained with present-day iron pole pieces, 7½ lbs. of Alnico V are used in the magnet structure. In general, the higher the flux density in the gap, the better the low-frequency damping. The tweeter is the pressure type using a parametric horn with an acoustic lens to obtain wide angle distribution.

Either of the two loudspeakers may be mounted in the exponential acoustical labyrinth cabinet, such as is shown in *Fig*. 5. This enclosure retains the ideal damping and loading characteristics of Benjamin Olney's original acoustical labyrinth, described in reference (1). In addition, it provides more extremely-low-frequency radiation than has been obtained heretofore. The absorbent material from which the labyrinth is constructed completely absorbs the back wave down to the middle low frequencies in the vicinity of 100 to 150 cps. Below this range the labyrinth extends the bass response and smooths out undesirable bass resonances. The length of the labyrinth is chosen so that it presents a high acoustical impedance to the speaker cone at the speaker's normal resonant frequency. A new resonance appears at a much lower frequency which is effectively damped by the radiation from the large open end of the exponential labyrinth. This improved bass loading virtually eliminates frequency doubling or tripling at low frefrequencies and provides much better transient characteristics than are obtained from conventional closed-back or bass-reflex housings.

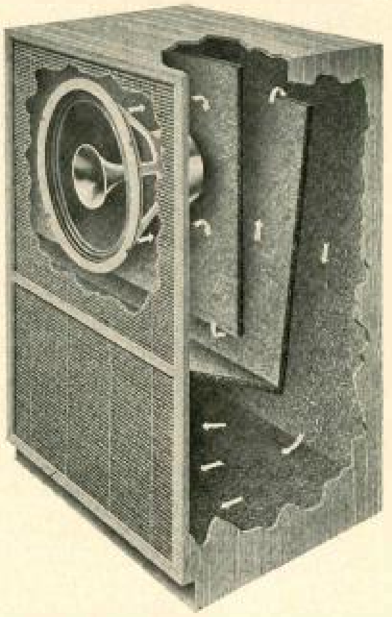

Fig. 5. The exponential acoustical labyrinth which accounts for good low-frequency response.

Figure 6 shows the electrical impedance of an RF-471 speaker in an infinite baffle compared with the impedance of the same speaker mounted in an exponential acoustical labyrinth. Notice that instead of a single sharp resonance at 52 cps, as in the infinite baffle, there are two broad resonances at 30 and 90 cps. The broader resonances mean smoother and less "tubby" re-

[*Continued on page 34*]

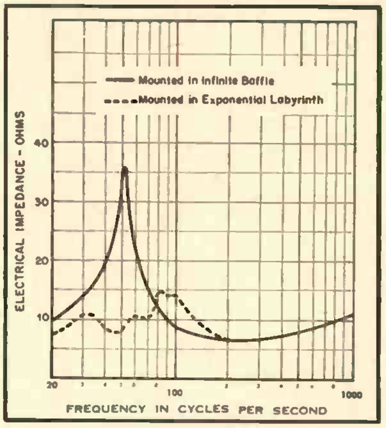

Fig. 6. Impedance vs. frequency curve of the 12-inch speaker in the exponential acoustical labyrinth.

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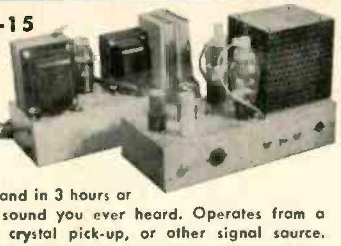

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Audio in the Home

William C. Shrader*

A review of some of the problems encountered in attempting to achieve the best performance possible over the range below 100 cps. The author compares speaker enclosures and makes recommendations as to the most suitable types for any given installation.

BECAUSE OF SPACE limitations in the June issue, some of the writer's comments on amplifiers were omitted. However, readers are admonished not to assume that omission of any particular equipment in these discussions does not indicate that it is not satisfactory—only that the writer has not had sufficient experience with it to give a qualified opinion. In this particular instance, the omitted amplifier ranks high—in the writer's opinion—among models best suited for home use.

Scott 210B and 214A

The Scott 210B amplifier is complete on one chassis with Dynaural Noise Suppressor. The 214A is similar, except that it has a remote control, with the Dynaural unit available as an accessory only. Hermon Hosmer Scott, the designer of these amplifiers, has an enviable background in acoustics. He designed measuring instruments for which he received the *Electrical Manufacturing* design award, and these two amplifiers have a flexibility of control which is not excelled by any other in this country. In place of the usual volume control, these models use a loudness control that automatically compensates for low-level listening. These amplifiers have sufficient boost available to give satisfactory results even with small speakers in inadequate cabinets. They are also available on special order with lower turnovers in the preamplifier and tone controls. That is, the bass boost starts at lower frequencies for those who insist on playing their systems loud or for those who have large cabinets where a great amount of boost is not necessary. With the standard type of amplifier, however, and with a good speaker system, the bass is likely to appear too boomy. It is recommended, however, for small housings and for speakers with inadequate bass, or for those who play their music at low volumes. Modified units are recommended with large speakers, properly housed, and when so used there is a more solid bass and a better definition that is quite obvious. It is the writer's opinion that the 210B is a very practical all-around amplifier for the music lover who has a large collection of records and who is less interested in machinery for its own sake than in the results he can get from his records.

The Scott 214A amplifier, with remote control, which permits more convenient mounting in usual home cabinets.

Now to Speakers

The highest of all hurdles to a good audio system in the home is the space required for the loudspeaker. Since science has found no way until recently to reproduce sounds in the low frequencies without air columns, cavities, or large sounding boards, the third of the living room that was formerly occupied by a grand piano, or a reasonably similar space, is usually allowed for the loudspeaker. But this need is quite at variance with the aims of the modern housewife or interior decorator, and those in apartments frankly do not have that much space available.

Because loudspeaker bass driver units of 12 or 15 inches in diameter are smaller than the wave lengths they must reproduce, their efficiency falls off (about 400 cycles for a 15 in. and double this for a 12 in.) far above the desired lower limit. As has been pointed out in other articles in Æ, a 12-in. speaker must move one full inch to put one acoustic watt into a room and, since it is impossible to drive a speaker one full inch, some other means must be found to increase its efficiency at these lower frequencies. There have been examples of enlarging cones as much as 27 in. (exhibited at the 1939 World's Fair) and 48 in. for a German model. But these had a very poor transient response because of their bulk, and magnets could not be made big enough within a reasonable price range to provide the necessary efficiency.

Multiple Speaker Systems

Multiple speaker systems are another way of increasing the efficiency in the low register, and these seem to be the most practical. However, in a small room, they present a problem of phasing. A person's voice, for example, comes from only one source in reality, and to have it spread over four diaphragms that are only a few feet away from your chair obviously does not give the proper illusion. This difficulty does not arise in large theatres as the speakers are far enough away to sound like one. However, it is practical to use two low-frequency speakers in a home. The two diaphragms act as one at these frequencies to aid each other in increasing the efficiency by something greater than a multiple of two and extending the range lower than would be possible with a single diaphragm.

Smaller Designs

Many designs and articles have been written on extremely small baffles. Western Electric designs many speakers for monitoring purposes in small studios and, because of their special cone construction, these use about the smallest baffles. But they must be used in absolutely air tight cabinets which are heavily lined with rockwool or Fibreglas to work well at all. Still, most of them are limited to above 70 cps, and because their construction represents a compromise between space and sound requirements, other designs have become much more popular.

Many people who are compelled to use a very small cabinet (less than 4 cubic feet) will prefer it with an open back because the juke box and ordinary commercial radios have accustomed them to a peak in the 100-200 cps range. Those who seek pure tones, however, do not want this peak and would, therefore, prefer the cabinet enclosed even though there is less apparent bass. A small cabinet design recently published and demonstrated at the Audio Fair is the little "R-J" (Frank Robbins and William Joseph, the designers), which is based on the Helmholtz Resonator. By lowering the efficiency in the upper frequencies and putting a very broad peak in the low register it appears to flatten the response and thus gives better bass response than would otherwise be possible with such a small cabinet. It is effective for its size, but it in no way takes the place of the 16-cubic-feet infinite baffle or the folded horn used in some loudspeaker systems.

The details of the various enclosures generally employed for home systems will be treated next month, with a description of the important considerations bearing on cabinet selection.

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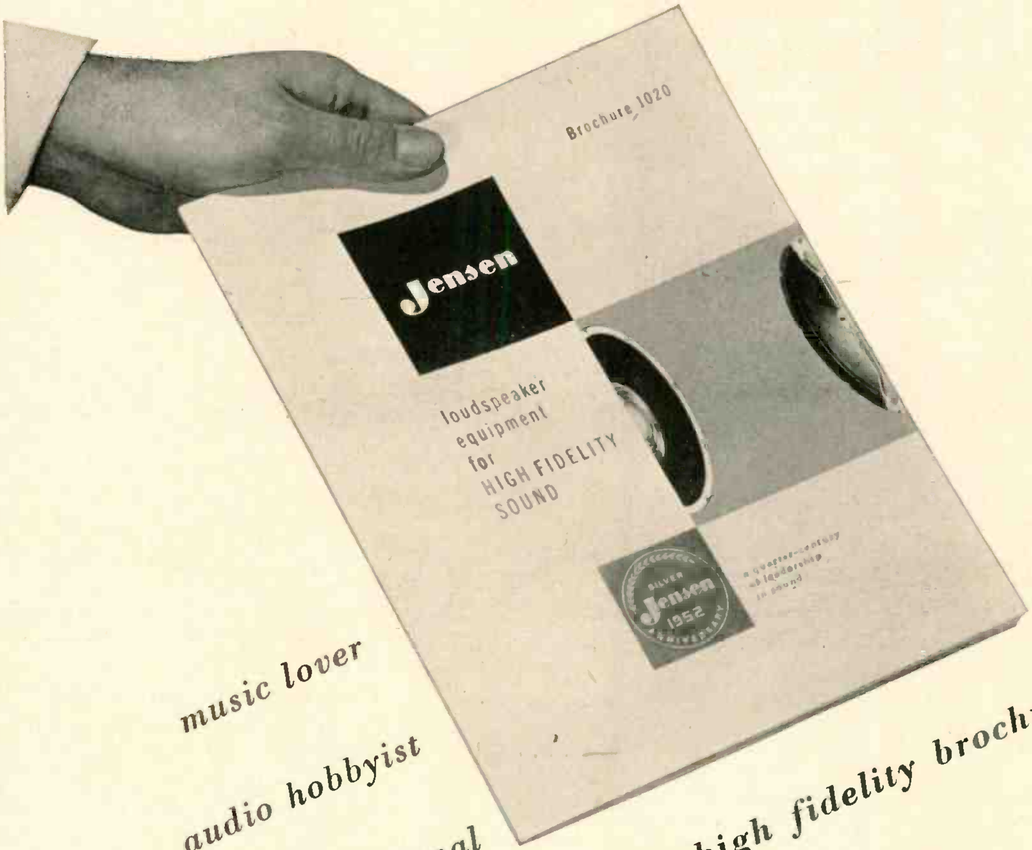
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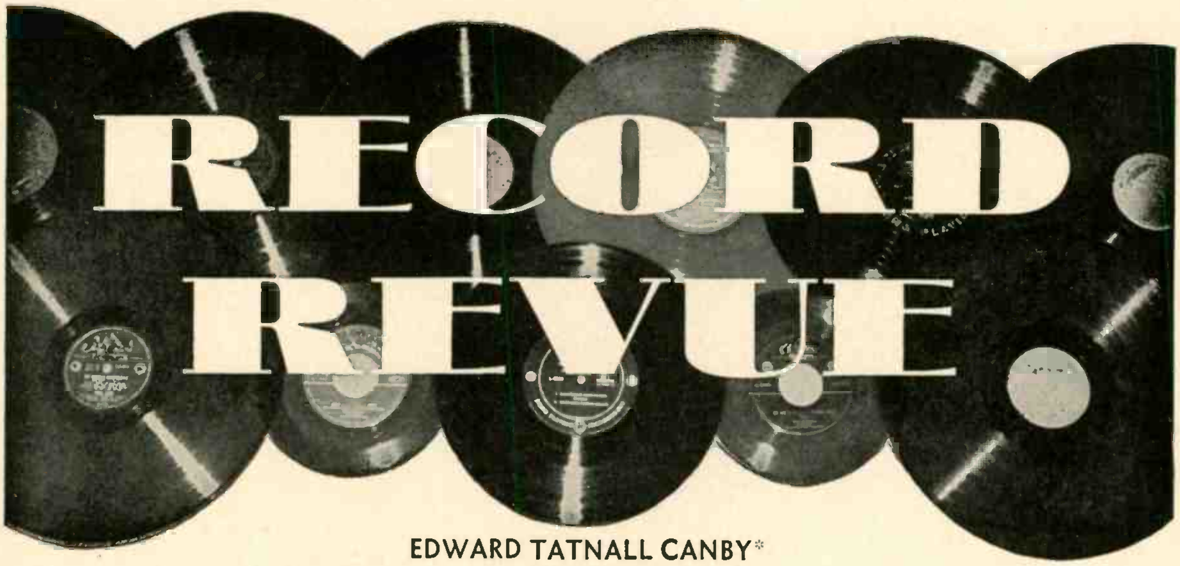

EDWARD TATNALL CANBY[*]

I'm writing a book. Not that this is a plug or anything of that sort, I hastily add. It's just that the thing, like all respectable books, is now a month overdue and I can't write a word without the leering ghost of my publisher peering over my shoulder, pointing at a calendar. Last month's calendar. You see, the book is about High Fidelity, better described according to this magazine's standards as Medium Fidelity. I trust it will enjoy a considerable sale among engineers and hobbyists who'll happily tear it to pieces to the tune of cash in my till—but the opus is actually aimed at that exasperating, wonderful, sensible person of intelligence, the amateur music lover who wants better music at home.

And the nice thing is that I have one of these people peering over my other shoulder and asking pointed questions—dreadfully pointed. She's the assistant editor in charge of me, and she's genuinely interested in High Fidelity—a business that was entirely new to her when I hove upon the scene. Not entirely new, I should say, for someone recently persuaded her to buy a new 3-speed changer for her elegant Capeworth—or was it Farneshart—to replace the old one-speed job and she's been having a bit of trouble . . . she's considering the possibility of junking All (except of course the new changer)—but the difficulties seem appalling and she's not too happy about these complications I write about, like equalization and intermodulation distortion. Please, Mr. Canby, make it simpler!

Quite seriously, this lady editor is in a position that impressively reflects the thoughts of about ten million people who at this moment are hovering about the edge of Audio and Hi-fi. I can't help hearing, in her neatly typed queries that are sent back with my pages of manuscript, the Voice of Destiny, so to speak. Nothing to laugh about. Most of the ten million just have their thoughts, and get them over with, minus answers. But this one soul, who has a mind that I've already learned to respect, can jab right at me from exceedingly close range.

Fidelity

She has an assortment of needle-sharp pins, with which to deflate my occasional outbursts of bombast in the great name of Audio. After one inspiring paragraph on the significance of the hi-fi movement and the tremendous spread of interest in better equipment and high-quality sound reproduction, I struck what I thought was a fine pay-off line. Sounded good. But she demolished it with a bright little question:

P. 6, 1st para. "The high fidelity listener is a person to be reckoned with." What means this?

Oof! What *does* it mean, I muttered, as I began all over again. It *did* sound just a bit marital, what with all this reproduction stuff.

Wires and Plugs

It's so easy to take things for granted that are nothing of the sort to the really intelligent reader who knows nothing about your subject matter. (And why should she or he?) Values are so different. What's important to the engineer is folderol to the music lover. Trivial matters like plugs and wires are major problems—obstacles—to most of the people who are now looking over this Audio business for the first time. I thought I was the People's Advocate in these matters; I've been talking about pre-wired units and fool-proof connections these many years. But I got tripped up on my own home ground. In my enthusiasm for the separate-unit system I went overboard for Flexibility—how good it was to be able to space your units around a room, the speaker in a corner, the changer perhaps in an inconspicuous drawer. But I forgot those infernal wires in my excitement:

P. 13. When separate units are installed in various parts of the room do you have wires running under rugs? How manage this?

She's absolutely right, of course. From the lady's point of view the wire-under-a-rug is a perfectly practical problem and no male casualness is going to make her spoil her rugs for any old separate unit. We"ll run them around the baseboard, then.

I suspect your merry "just plug it into the system" [extras like radio tuners, etc.] involves wiring, not the kind of plugging you do in a lamp. Is this true?

She's wrong for once—I *did* mean plugging. Thanks to the cooperation of the parts stores these days. But she was right to question it. There'll be no wiring done in *her* house. Nor in those ten million other houses, where "hi-fi" is a prospect. Most of these people are out for the real essentials of hi-fi, the use of the equipment itself and the enjoyment of the music produced. Wiring is a chore that they cannot give time to, nor should they if they feel so. Must one necessarily learn to solder in order to enjoy fine music?

On Faith

My editor is by no means confined to wires in her interest and her willingness to go along with me—if I persuade her. The deep end is pretty close in this sort of thing. Tone controls? Got to explain equalization. And for that you'll have to get into recording curves—which leads one inevitably to the reason for bass attenuation on all records—and that leads to the nature of sound waves. I went bravely into it all and she came along right after me, swimming hard in strange waters. Amplitude, needle excursion, longitudinal pressure waves vs. lateral grooves, compound wave traces expressing many frequencies simultaneously. . . .

Ch. 5. . . . I understand the difference in wavelengths, but when we get the needle darting back and forth (the tracing on the record isn't a reproduction of sound pattern, is it? Otherwise how can it pick up chords? It's both high and low at once in music.) So I began to flounder. Maybe I must just take this one on faith?

By all means, no! The thing about this unusual lady editor is that she doesn't just sag mentally, taking things on faith rather than bothering to think them out! I call this to witness as your best evidence that the people who are on the reeciving end of hi-fi, however little they know, have an IQ that no doubt is precisely the same on the average as that of the engineer and audio hobbyist.

Look at the revelations that came to her here, in midstream, right in the middle of a sentence—things that we take for granted, matters which most people never even bother to think about. Is the tracing on the record a reproduction of sound pattern? Of course—but how many intelligent

[*Continued on page 43*]

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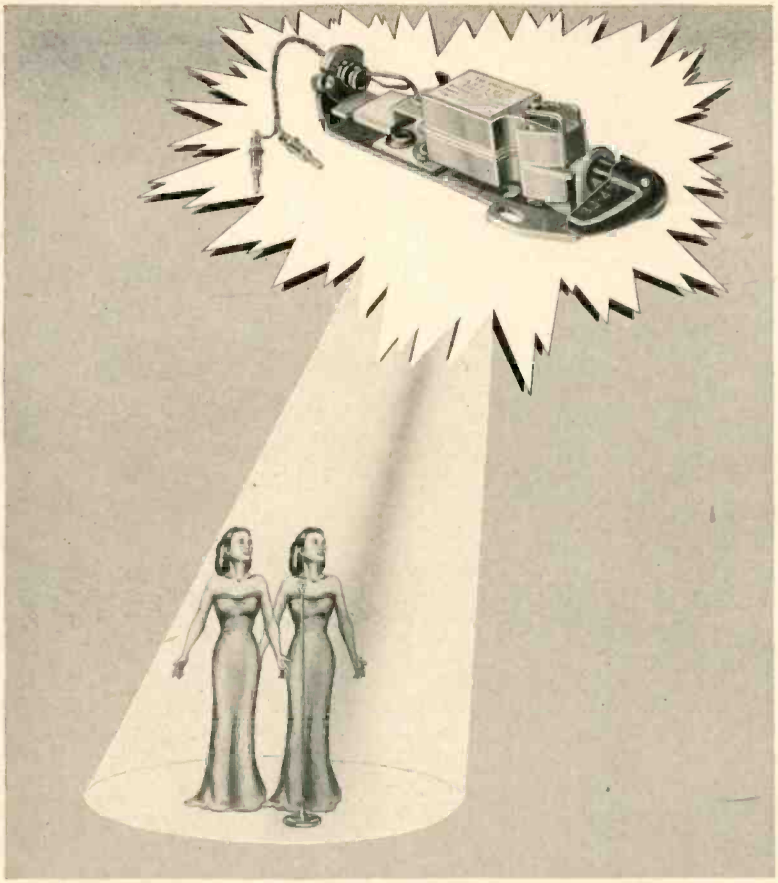
[*] *279 W. 4th St., New York 14, N. Y.*



HI-FI EQUIPMENT

[*from page 28*]

sponse. The new resonance at 30 cps indicates the extension of the bass to extremely low frequencies. When the RF-475 is mounted in the exponential labyrinth, the low resonance is below 20 cps, providing clean bass reproduction in the 20- to 30-cps range.

During the design period, the engineering models of the tuner, amplifier, and loudspeakers were checked at frequent intervals both by conventional laboratory methods and by comparative listening tests with the best program material available. Quantitative measurements of frequency response, distortion, intermodulation, etc., are invaluable tools and do provide a description of the finished product. However, quantitative measurements do not tell the complete story. Unless careful listening tests are used as a check on the progress of the design, the engineers may end with that distressing phenomenon, an amplifier or loudspeaker that "measures well, but does not listen well." Even listening tests, however, can be misleading unless there is a standard with which the listener can make a reliable comparison. There is only one primary standard of excellence in music—the original live concert. For that reason, engineers conducting the listening tests made it a point to attend live symphony concerts as often as possible. Live FM broadcasts and the best LP records or original tape recordings that could be obtained formed the secondary listening standards. The Custom Four Hundred line is the result of the combined effort of several engineers, all of whom were looking for the maximum listening pleasure as well as impressive measurements.

RADIO STUDIO

[*from page 21*]

control rooms. They frequently cause electronic interference in the form of a rough buzz in low-level inputs, and often produce audible hum from their reactors. A common and attractive incandescent fixture for studios is the square, flush-mounted Holophane fixture. The lighting level in studios and control rooms should be 30-foot candles, minimum, and in general, the spacing of the lights should be governed by this requirement. However, light spacing must sometimes be modified to avoid interference with air conditioning outlets. In control rooms, the fixtures should be located to illuminate the equipment and desk areas, and to minimize reflections in the inclined window. To avoid complete darkness in case of fuse burnout, split up the studio lights into separately-fused strings, and put each string on a separate silent mercury wall switch to economize on lighting power when studios are idle.

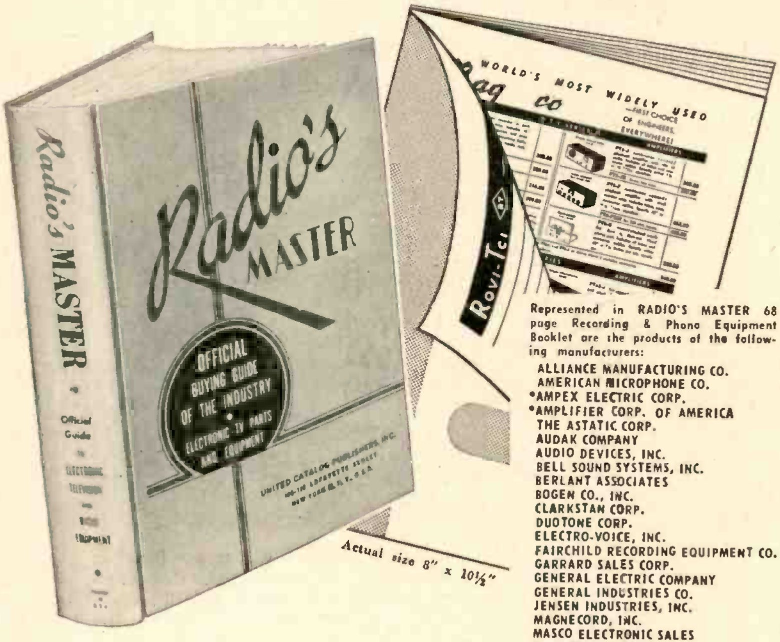
Provide plenty of conventional utility outlets in studios, control rooms, recording rooms, shops, and offices. One of the most convenient ways of doing this is to use wired plugmold located on top of the baseboard. This is a metal molding available with single outlets every six inches or eighteen inches and is wired ordinarily for a total connected load of twenty amperes. Its use makes available a.c. outlets wherever a recorder or console may be located. It's a good idea to control this circuit by a master switch on the wall near the door, and to install a pilot light in the wall visible from the corridor through the control room door port. The alternative to wired plugmold is to specify individual outlets at each equipment location, which should be indicated on a sketch. In this connection, surface-mounted outlet boxes are preferred to the more common flush-mounted type in soundproof walls, as the removal of mass from the wall to accommodate flush boxes is a possible source of sound leakage. Make sure the contract calls for careful plastering to calk the relatively small cracks around the conduits feeding the surface boxes. If flush boxes must be used, pack the space inside with Duxseal, including the opening into the conduit. This is a heavy, flexible, solid of the consistency of putty, but unlike the latter, it does not harden, and can be removed for future work on the box wiring.

Specify the location of all a.c. distribution panels and a choice of either fuses or circuit-breakers. The panel should be located in a surface cabinet placed where it will never be covered by a rack or other tall equipment. An ideal location from an accessibility viewpoint is over a disc recorder or a turntable or other gear of low height. Use separate distribution panels for each studio-control room combination.

Be sure to specify wiring for on-the-air signs and similar signal lights, and to specify their locations and the locations of the points where their conduits join the control element—generally the console. It is sometimes more convenient to let the sign contacts on the console microphone keys control red and green mike indicator lights in the studio, and to control the on-the-air sign (and other signs) from separate switches independent of the console.

There remain miscellaneous circuits —intercoms, telephone, and buzzer systems—for which outlets should be located and conduit run. If any of these appear in the studio, it is desirable to interlock them with the on-the-air sign through a relay to guarantee against program interruption.

Wiring will be needed for clock systems. Some broadcast clocks are operated by a spring which is kept wound by a motor energized by dry-cells in the clock housing. This clock is corrected by a signal received over a line from the local telegraph office, and a conduit must be provided for the correcting circuit. Other types of clocks are powered by the building a.c. for which circuits must be run. These clocks may be electronically regulated by tone signals impressed on the a.c. as a carrier by a low-power



radio transmitter triggered by a master clock, both of which are usually located in the studio building. A tiny receiver in each slave clock does the rest. When the correcting tone frequencies are in the audio spectrum, filters may be required to keep these tones out of the studio audio system.

A few last points on studio electrical work. If the area has a history of frequent and severe voltage fluctuations, you may be plagued by variations in turntable and recorder speeds and annoying flickering of lights. In such cases, it is wise to incorporate constant-voltage transformers or other voltage-regulating devices as part of the studio a.c. system. Also, check on the local power frequency. Hammond organs for 60 cps are hard to start on 50 cps and speak several half-tones off, and on 25 cps, you'll have trouble with all sorts of 60-cps equipment. Finally, where armored circuits must go through double walls, make sure the contract calls for inserts of flexible (Greenfield) conduit within the wall. Just one rigid conduit bridging the airspace in a double wall can throw away much of its sound isolation value. Audio conduit will be discussed in a subsequent installment.

GILDING THE LILY

[*from page 14*]

is around 63 ma, and no trouble should be encountered in obtaining the power levels or the low distortion of the Musician's Amplifier. Hum and noise in the power amplifier are inaudible.

Front End

The authors are well aware of the fact that no "front end" or preamplifier was described in the original paper and have had much correspondence with readers on the subject. Subsequent to the original paper, articles on front ends have appeared in these pages as well as in other publications. Some have been complex and expensive; others have been simple and inexpensive. In our own case, of course we have built front ends; some of these have been good, while others have been not so good. One of the big reasons for our not describing a front end has been that we have not been so sure of the features to be incorporated in the ideal front end and the almost unsurmountable obstacle to the amateur constructor in achieving the appearance of a factory built unit.

The requirements for a front end for the Musician's Amplifier are many and most rigorous: (1) It must have *very* low distortion; (2) it must have *very* low noise and hum level; (3) it must have a response which approaches, at least, that of the power amplifier; (4) it must be capable of being installed at some distance from the power amplifier with absolutely no degradation of performance; (5) it must provide a high-quality preamplifier for magnetic phono pickup; (6) it must provide adjustment to compensate for the various recording equalization curves in use today or which have been widely used in the past; (7) it must have facilities for "tone compensation or adjustment" in addition to phono compensation, and which do not degrade the quality of program material or sound; (8) it must have medium-gain, flat-response inputs for FM tuner and tape; (9) it must have (for the benefit of the ladies) eye appeal and particularly must have a minimum of knobs and adjustments; (10) and perhaps most important, it must be moderate in cost without degradation of performance or facilities. This is a big order, and while we have built front ends which meet most of the electrical requirements, they often did not look good enough to warrant an article, largely because of our lack of manufacturing facilities.

We have now adopted the Altec Lansing A-433A remote amplifier as a very satisfactory front end. It meets all of the requirements laid down above and when the price is considered it is far less expensive and eminently more satisfactory for the amateur to buy than to attempt to duplicate with the usual home facilities. Furthermore, the connection of the A-433A to the Musician's Amplifier is very simple and can easily be done by anyone reasonably handy with a soldering iron and a few tools. The output of this front end is a cathode follower with output impedance of less than 1000 ohms so that no high frequencies are lost in cable capacitances.

When this front end is used, the combination should be perfectly stable. If motorboating is encountered, check filter capacitors in power amplifier. If at a maximum bass boost the speaker cone "breathes" subaudibly, decrease the value of the coupling capacitor between front end and power amplifier to 0.03 μf *or* decrease grid resistor from 1.0 meg to 0.47 meg. No audible difference in sound will be apparent.

The A-433A when used in conjunction with the Musician's Amplifier has more than adequate gain, particularly on phono input. At settings of the volume control which give very loud volume with low-output pick-ups there should be no audible hum. At full rotation of the volume control some hum may be heard, but not all of this comes from the front end. Some will come from stray magnetic fields, poor shielding on pick-up leads, etc. The hum level may be adjusted for optimum by removing the ground from heater center tap and connecting a ground to the moving arm of a 50-ohm pot across the heaters. With this arrangement, we have been able to reduce to almost inaudible levels the hum heard when on phono, the volume control wide open (far more than ever needed) and nothing connected to the input.

The authors wish to acknowledge the invaluable assistance of Ralph Ellison in constructing the experimental models of the amplifier.

NEW PRODUCTS

• **Sound Survey Meter.** Although extremely small in size and light in weight, the new General Radio Type 1555-A sound survey meter will perform many of the functions normally expected only of standard-size instruments. Audio engineers will find the meter useful in adjusting the relative level of speakers, and in checking their dynamic range and frequency response. College and high-school physics laboratories will find many ways in which the instrument can be used to demonstrate sound phenomena. Although a pocket-size instrument, the 1555-A can be tripod-mounted. Only two controls are used, both of which are conveniently mounted on the front panel. Total sound-pressure-level range of the meter is from 40 to 136 db, and three frequency-weighting networks are provided. Price is exceptionally low for a precision-built instrument. General Radio Company, 275 Massachusetts Ave., Cambridge 39, Mass.

• **Tannoy Loudspeakers.** Newest items from the British Isles to make their appearance in the American audio market are the well-known Tannoy "Dual-Concentric" speakers. Introductory announcement from the manufacturer stresses the ability of the Tannoy units to provide a frequency response substantially flat from 40 to 20,000 cps. In construction, the speakers include a high-frequency transducer inside the magnet assembly which is correctly matched to an acoustical transformer. The low-frequency-cone unit is largely conventional. Available in 12- and 15-in. diameters to handle 15 and 25 watts respectively. Complete information may be obtained from the manufacturer's American representative, Beam Instruments Corporation, 350 Fifth Ave., New York 1, N. Y.

• **Control Amplifier.** Designed for use with high-quality basic amplifiers, the new Brociner Model CA-2 Control Amplifier is a self-powered remote unit of professional caliber. Controls include input selector, separate tone controls for treble and bass, and volume-on-off control. Precision-built in all respects, the CA-2 affords a degree of flexibility of control which is unique in the field of amplifier design. Special low-noise resistors are used at critical points in the circuit. The CA-2 is designed for use with a separate preamplifier when magnetic pickups are used, and is matched in characteristics with the Brociner Model A100 preamplifier-equalizer. Frequency response of the CA-2 is 20 to 70,000 cps within ±1 db. Cathode-follower output permits use of long cable to main amplifier without impaired performance. Brociner Electronics Laboratory, 1546 Second Ave., New York 28, N. Y.

• **Improved Magnetic-Tape Reel.** Reduction in program-timing error is afforded by a new 7-in. plastic reel recently announced by Minnesota Mining and Manufacturing Co., 900 Fauquier St., St. Paul, Minn. Introduced essentially for professional recording where the timing accuracy of the NAB-type reel is required, yet where the size and economy of the 7-in. spool are preferred, the new reel features a 2¾-in.-diameter hub which affords the same 2½-to-1 ratio of outside diameter to hub diameter as that of the standard 10½-in. NAB reel. Closer speed control permitted by the larger hub also minimizes pitch changes in edited tape. Slower rotational speeds produce smoother rewinding with reduced vibration. Distributed in a new grey-and-plaid box as No. 111-AP, the spool contains 1200 feet of ¼-in. splice-free Scotch tape.

• **New Partridge Output Transformer.** Builders of high-quality amplifiers will be quick to explore the potential of this British-made transformer designed to provide 16 watts of audio output with less than 1 per cent distortion. Frequency curve published by the manufacturer indicates response within minus 2 db from 10 to 70,000 cps. This figure does not take into account the effect of negative feedback. Secondary winding of the unit is brought out as two separate sections which may be connected either in series or in parallel, thus insuring optimum performance with speakers ranging from 4 to 16 ohms. Characteristics of the transformer, which is designated Type P1292, permit its use in circuits where considerable feedback is taken from the secondary winding and injected into a point three or four stages back. Partridge Transformers Ltd., Roebuck Road, Tolworth, Surrey, England.

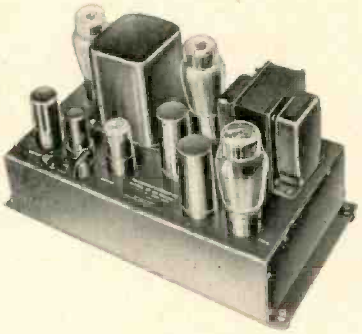
• **Preamplifier Power Supply.** Although particularly well-suited for powering the McIntosh Type AE2-A preamplifier-equalizer, the new McIntosh D-101 power supply may be used to equal advantage wherever similar voltage and current requirements are encountered. The unit was designed for powering the AE2-A when it is used apart from the McIntosh power amplifier, or when the distance separating the two units is greater than 30 feet. McIntosh Laboratories, Inc., Binghamton, N. Y.

• **Tape and Film Splicers.** Designed to splice ¼-in. magnetic recording tape, 16-, 35-, or 70-mm microfilm or motion picture film without scraping or the use of cement, the new Presto-Splicers achieve a splice which will hold even under the hot developing process used for high-speed production of TV newsreel and Ultrafax film. Magnetic tape splices will withstand a 3-lb. pull. Operation of the Presto-Splicer involves a combination of controlled heat and pressure, applied in precise, automatically controlled time cycles. The resultant splice does not add to the thickness of the tape or film, and the butt-welded ends produce a homogeneous bond, with no loss of either picture or sound. The complete cycle of operation requires only 6 to 10 seconds after editing. Model MT-1, illustrated, is for splicing tape, while the PRO model is designed for film. Prestoseal Manufacturing Corporation, 38-01 Queens Blvd., Long Island City, N. Y.

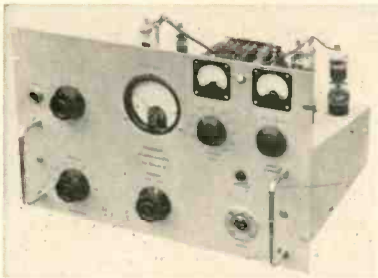
• **Transcription Player-P.A. System.** Both operating utility and audio performance are well represented in a new series of portable record players and P.A. systems recently announced by Masco Electronic Sales Corp., Long Island City, N. Y. All models in the new line feature a 2½-lb.

12-in. turntable and offer a choice of crystal or magnetic pickup. Separate controls are supplied for phono and microphone, as well as for treble and bass. Power output is 10 watts with less than 5 per cent distortion. The units are attractively housed in a sturdy plywood carrying case. Weight is 35 lbs.

- **High-Quality Audio Amplifier.** Low distortion and exceptionally wide frequency response at full output are inherent in the new SR-88 amplifier recently introduced by The Sargent-Rayment Co., 212 Ninth St., Oakland 7, Calif. In announcing the new amplifier, the manufacturer stresses its ability to maintain less than 0.5 per cent harmonic distortion from 30 to 15,000 cps at full 15-watt output. Frequency response is ± 0.2 db from 20 to 20,000 cycles. Twenty-six db of inverse feedback affords high damping factor. Descriptive sheet will be mailed on request.



- **Feedback Recording Amplifier.** The Grampian R.A. 3 unit is a main amplifier with a built-in power supply, and incorporating two feedback networks—one which gives up to 30 db of feedback from the cutting head and one which is used to provide the high-frequency equalization to suit modern recording characteristics. This boost is controllable from the front panel over the range from 0 to 10 db (at 10,000 cps). The frequency range of the amplifier is claimed to be flat ± 3 db up to 15,000 cps, with appreciable output up to 20,000 cps. Excellent transient response and low distortion are attested by the quality of such Mercury records as "Pictures at an Exhibition" and Tchaikowsky's "Fourth Symphony." The Grampian amplifier and feedback cutterhead are distributed in the United States by Reeves Equipment Corp., 10 E. 52nd St., New York 22, N. Y.



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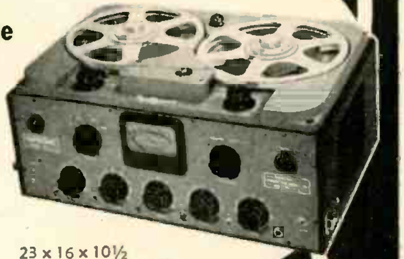

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√ 4 inch calibrated V.U. meter
√ Controls: Separate bass & treble; special pad for controlling speaker level while recording; mixer-fader arrangement for external imput
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√ 2 imputs: Hi impedance mike w/mixing control; external hi impedance w/separate mixing controls
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SOUND REPRODUCTION

[from page 18]

with the tone controls of a phonograph indicates that reducing treble amplification changes the character of surface scratch, while reducing bass amplification cuts down turntable rumble.

All noise, although it is of random wave form, may be analyzed like any complex wave into an equivalent group of sine waves.

Wave Envelope

The wave envelope of sound is an imaginary pair of lines connecting the peaks of the individual cycles. *Figure* 2-8 shows several types of wave envelope—that of a percussive sound, that of a sound which slowly gathers volume and then dies away, and that of a sound with an amplitude vibrato.

The wave envelope has a marked influence on the character of the sound, to the extent that if it is severly altered the sound may become unrecognizable. Asymmetrical wave envelopes such as that of (A) *Fig.* 2-8 may be experimentally tampered with, allowing all other elements to remain unchanged, by playing a record or tape backward, a procedure which interchanges the rates of growth and decay. Piano music reproduced backwards sounds like the music of a small organ or accordion with peculiar note endings. Speech not only loses its intelligibility but changes its national character, and an American folk singer pronounces words which sound in turn Swedish, Russian, and French.

Transients

The wave form of the first cycle or cycles of a musical sound may be quite different from the wave form after the sound has reached its normal or steady state. For example, the initial deformation of a percussive source as it receives its blow, from rest position to maximum displacement, may occur in much less time than the ¼ period taken up by this journey when the source is vibrating freely at its natural frequency. Furthermore, whatever the momentary frequency during the first few cycles, the wave form may be far different from what it is like in the steady state, and may contain entirely new frequency components.

Momentary effects of this nature are called transients, since like the traveler of that name, they do not stay. They are associated with the starting and stopping of sound, or with sudden changes. Their existence is fleeting, but they have a pronounced effect on the over-all character of the sound.

See you at Long Beach
Western Electronic Show
and Convention
August 27, 28 & 29

TAPE RECORDER

[*from page 23*]

equal success, if desired. When dubbing, Sw_1 should be in the REC position.

Power Supplies

Two power supplies have been built to use with this unit—one remaining in the fixed installation, while the other is mounted in the carrying case for field use. Both have similar characteristics, and are similar in design, although differing in detail.

The fixed unit is shown in *Fig.* 14, with a schematic as shown in *Fig.* 15. In the original unit, the transformers used were obtained at surplus, but the accompanying parts list employs standard jobber items.

This power supply uses a tube rectifier for the plate supply, which must furnish 35 ma at 300 volts for the amplifier, and about 40 ma at the same voltage for the oscillator in the recorder case. It must also furnish 6.3-volt a.c. for the heater of the oscillator. The amplifier heaters all operate from 12-volt d.c. obtained from filament windings on the transformer and selenium rectifiers. A study of *Fig.* 1 will show a rather unique arrangement of the heaters. This was used so as to minimize the change in voltage on any of the tubes in case of failure of one of them. The VU meter is illuminated by two pilot lamps connected in series—a 3.3-ohm resistor serving as the connecting lead. This is easily done with the General Electric meter, and with the lamps specified, the current through this portion of the heater circuit is equivalent to that of a tube. It will be noted that this arrangement of series-parallel heaters simplifies wiring, in addition to its more obvious advantage in maintaining reasonable voltage on any heater in case of a failure.

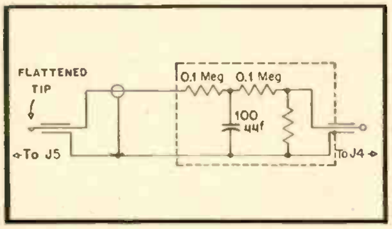


Fig. 13. Schematic of patch cord used for making artificial reverberation machine out of the amplifier.

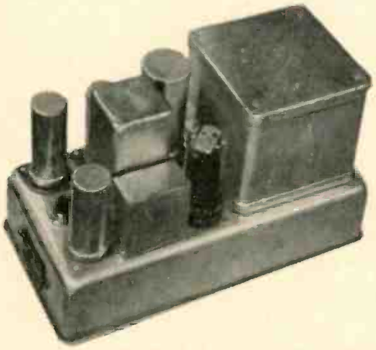


Fig. 14. External view of power supply used in the fixed installation.

Two outputs are provided for this power supply—the Amphenol 91PC-4F provides power to the amplifier while the Jones S-406AB furnishes a.c. at both 6.3 and 115 volts to the recorder, as well as 300-volt d.c. and ground.

The portable power supply is somewhat smaller, and employs selenium rectifiers for both heater and plate voltages. It is constructed in a Bud Minibox, 3 1/2×6×8. The power receptacles, a.c. switch, fuse, and input cord are all mounted on one of the ends of this box, and all parts are attached to this same section of the box. The schematic for the portable power supply is shown in *Fig.* 16. Since space is important, and since selenium rectifiers are used for the B-supply, it is suggested that the specific parts named be employed for this unit. Internal construction is straightforward, and can be laid out by the builder to suit his own requirements.

Carrying Case

For field use, a carrying case was built by a local luggage shop, being constructed of 3/8-in. plywood and covered with a material which matches the recorder case. The case is a fairly tight fit for both amplifier and power supply,

and is lined with thick felt to prevent jarring within the case. The partition between the power supply and amplifier compartments extends to about two inches from the bottom so as to provide ventilation through two vent-holes in the side of the power supply. Circulating air currents can thus pass through the unit and out through the vent hole in the top panel.

Conclusion

The design and construction of a unit such as this is a somewhat complicated procedure, and was not done in a week. However, this equipment has been in use for almost a year and no trouble has developed. Those experienced in miniaturizing equipment such as is done for military uses will undoubtedly be amazed at all the waste space in the amplifier; on the other hand, anyone who has not attempted extra-small construction may be confused by the lack of space. Unless your requirements indicate a particularly compact construction, it is suggested that an electrically similar unit would be much easier to build in a case two inches larger in each dimension. Now that it is complete, however, the writer has no hesitation in recommending the unit to anyone with similar desires in equipment.

Note: In reference to the suggestion about the substitution of the 5881 for the 6Y6G normally employed in the oscillator of the Presto RC-7 recorder unit, it seems desirable to clarify the ratings mentioned in last month's article. While the maximum plate voltage for amplifier use is listed as 200, the 6Y6G in oscillator service is rated for a maximum plate voltage of 350. Thus our concern about exceeding ratings was unfounded.

PARTS LIST

Portable power supply—Fig. 16

C_{21}, C_{22}, C_{23}	40 μf, 450 v. electrolytic
C_{24}	2000 μf, 15 v. electrolytic
F_{21}	3-amp fuse, Type 3AG
J_{21}	Amphenol, 91PC-4F receptacle
J_{22}	Jones, S-406-AB
L_{21}	8 H, 80-ma. choke, UTC R-18
L_{22}	8 H, 40-ma. choke, UTC R-14
R_{21}	22 ohms, 1 watt
SR_{21}, SR_{22}	Federal 1017 selenium rectifier, 600 ma, 26 volts
$SR_{23, 24, 25, 26}$	Federal 1002 selenium rectifiers, 75 ma, 130 volts
Sw_{21}	DPDT toggle switch
T_{21}	Merit P-3051 (260-0-260 at 70 ma; 5 v at 3 a; 6.3 v at 3 a.)

PARTS LIST

Fixed power supply—Fig. 15

C_1	2 μf, 600 v, oil filled
C_2, C_3, C_4	40 μf, 450 v, electrolytic
C_5	2000 μf, 15 v. electrolytic
J_1	Amphenol 91PC-4F receptacle
J_2	Jones S-406-AB receptacle
L_1	6 H, 100 ma filter choke
L_2	20 H, 40 ma filter choke
R_1	1000 ohms, 10-watt, Ohmite Brown Devil
SR_1, SR_2	Federal 1017 selenium rectifiers, 600 ma, 26 volts
T_1	350–0–350 at 90 ma; 5 v at 2 a; 6.3 v at 3 a.
V_1	6X5

RECORD REVUE

[*from page 32*]

people even know that? And if it is—then how can it be *both low and high at the same time?* An extremely logical question. The lady suddenly discovers, in a flash, the whole complexity of the compound wave shape and the astonishing ability of the ear to analyze the single recorded hair-line pattern into an entire symphony orchestra of chords and timbres! No, I don't want her to take anything on faith if I can help it. Too much faith is a dangerous thing and we in audio are depending pretty heavily on it as it is.

Practical minded, some people are. Take this, re equalization.

Does this matter of equalization compare to the treble-bass on my radio, which you adjust depending on the record and if you want to hear the bass or the speaking voice? Like the town–country affair on the radio in a car?

You see what taking on faith involves! Does *that* reflect the fine muddle of current set advertising? Well . . . yes and no, I'd say. The idea is right—but where did that town and country business get in? Better write that section over, too.

The original title of this book was to be "High Fidelity and the Music Listener," which I thought was pretty darned good. I wrote a whole chapter around the idea. But last week I suddenly found it had been changed, rather drastically. "Home Music Systems" is the uncompromising line of the publisher's current thinking. Seems somebody got started on that marital business again.

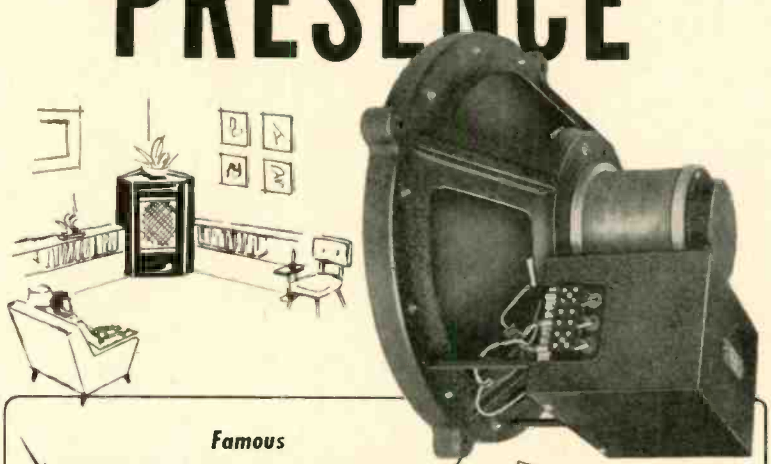
THE CANBY SUMMER "POPS"

Eight Recorded Programs of New Records

(What is a "Pops" concert? The famous Boston "Pops," the old original, sets a musical standard for "Pops"—good music of every sort from Schubert to show tunes, played beautifully and absorbed along with light refreshment, outdoor cafe style, the audience seated around tables.

You can make your own "Pops" from the new records; here are eight musical menus to sample, of a wide range of interest for not-too-heavy listening in hot weather, preferably with iced liquids. Not all up to Boston standards, but the best are terrific.—E.T.C.)

[*] **An outstanding record of its type.** [a] Unresonant, deadish acoustics. [aa] Anacoustic chamber. [b] Big bass. [c] Close-to, edgy highs. [cc] Crashing cymbals, etc. [d] Distortion present. [e] Edgy, sharp highs. [f] Flattish high end; needs boost over normal LP playback [k] From acoustic 78 originals. [l] Big, live acoustics. [m] distant miking. [o] From older 78 discs. [p] Piano is excellent. [q] Volume compression — taken from broadcast lines? [s] Some surface noise. [t] Good for transients. [v] Solo very close (Voice tonsil-close). [x] Bass seems weak; needs boost over normal LP playback. [y] Lacks highs.



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AMPLIFIER *Features*

- First Williamson Type Amplifier supplied with matching preamplifier
- Uses Altec Lansing Peerless output transformer.
- Practically distortionless — Harmonic and intermodulation distortion both less than ½ of 1% at 5 watts output.
- Frequency response ± 1 db from 10 cycles to 100 kc.
- Output impedance 4, 8, or 16 ohms.

The new Heathkit Williamson Type Amplifier kit is the best obtainable in amplifiers today—the choice of the really discerning listener. You can hear the difference and measurements actually bear out the superb performance. Frequency response ± 1 db from 10 cycles to 100 kc allow you to hear the highs and lows with equal crispness and clarity. Harmonic and intermodulation distortion both less than ½ of 1% at 5 watts output eliminate the harsh and unpleasant qualities which contribute to listening fatigue.

The circuit is similar to the one published in Audio Engineering Magazine for November, 1949, and is considered by engineers throughout the audio field as one of the best ever developed. The Main Amplifier (which may be purchased separately) consists of a voltage amplifier and phase splitter using a 6SN7, a driver stage using a 6SN7, and a push-pull output stage using a pair of 807 tubes. The output transformer is manufactured by the Peerless Division of Altec Lansing and is built to their highest standards. Output impedances of 4, 8, and 16 ohms are available. The power supply uses a separate chassis with husky Chicago Transformer power transformer and choke, and 700V Mallory filters for long hum-free operation. A 5V4G rectifier is used.

The main amplifier and power supply are each on a chassis measuring 7" high by 5½" wide by 11" long.

PREAMPLIFIER AND TONE CONTROL UNIT KIT

The preamplifier kit consists of: a 12AX7 (or 12AY7) dual triode first amplifier stage with a turn-over control for LP or 78 record types, and a 12AU7 amplifier stage with individual bass and treble tone controls which each provide up to 15db of boost or attenuation. A switch on panel selects either magnetic, crystal, or tuner inputs. Preamplifier also is well suited to custom installations — it will operate in either vertical or horizontal position, and special notched shafts of the controls and switches allow a variety of shaft lengths to be selected. Dimensions: 2¼" high by 10¼" wide by 7¼" deep.

Heathkit
AMPLIFIER
KIT

WA-A1 Amplifier kit — Combination 1 — (Main Amplifier and Power Supply) complete with WA-P1 Preamplifier kit. Total Ship. Wgt., 34 lbs. (Shipped Express only) $69.50

WA-A1 Amplifier kit only — Combination 4 — (Main Amplifier and Power Supply). Less WA-P1 Preamplifier. Total Ship. Wgt., 29 lbs. (Shipped Express only)............$49.75

WA-P1 Preamplifier Kit only. (less power supply) (Tubes included). Total Ship. Wgt., 7 lbs. (Shipped Express or Parcel Post)............$19.75

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1

el **Tchaikowsky, The Months, arr. Gould** Morton Gould (pf.) and His Orch.
Columbia ML 4487

*b **Enesco, Roumanian Rhapsody #2.** Orch des Concerts Colonne, Enesco

d **Smetana. The Moldau.** Austrian Symph., Singer.
Remington R-149-52

2

*lt **Harp Music (16th c. Spanish; Contemp. French and Spanish.)** Nicanor Zabaleta.
Esoteric ES 509

*l **Showboat Scenario; South Pacific; Slaughter on Tenth Av.** Phila. Orch. "Pops"., Kostelanetz.
Columbia ML 4514

3

*ccl **Ballet Music from Aida and Faust.** Metropolitan Opera. Orch., Fausto Cleva.
Columbia ML 4515

od **Richard Tauber Favorites.**
Decca DL 9597

*(d)s **Kurt Baum—Famous Tenor Arias.**
Remington R-199-63

* **George London—Dramatic Scenes from French and Russian Operas.** Met. Opera. Orch., Morel; Adler.
Columbia ML 4489

4

*k **Rosa Ponselle (10 solos and duets).**
Golden Legend LP 1201

qd **Rossini-Respighi, Rossiniana.** Berlin State Opera. Orch., Steinkopf.

Janacek, Sinfonietta (1925). Radio Leipzig Symphony, Neumann.
Urania URLP 7030

*eb **Strauss, Simphonia Domestica.** Vienna Philharmonic, Krauss. **London LLP 483**

5

*l **Stokowski Conducts Grainger;** assorted arrs. Leopold Stokowski and His Orch.; Percy Grainger, pf. **RCA Victor LM 1238**

vl **A Margaret Truman Program.** With RCA Victor Orch., Fiedler. **RCA Victor LM 145**

*ccl **Rimsky-Korsakov, Coq d'Or Suite: Capriccio Espagnol.** French Nat. Symphony, Desormière. **Capitol P-8155**

*cc **Rimsky-Korsakov, Capr. Espagnol. Tchaikowsky, Marche Slav. Mendelssohn, Fingal's Cave.** Boston Pops, Fiedler.
RCA Victor LM 164

6

*y(f) **Debussy, Petite Suite (arr. Busser). Roussel, Petite Suite.** Radio Berlin Symph., Celibidache. **Urania URLP 5006**

yl **Sibelius, Pelléas et Mélisande; Karelia Suite.** Radio Berlin Symph., Blomstedt.
Urania URLP 7038

y **Massenet, Scènes Pittoresques.**

y **Saint-Saëns, Concert Piece for Harp and Orch.** Radio Berlin Symph., Ludwig.
Urania URLP 7039

7

*ps **Liszt, Sonata in B Minor; Funerailles.** Simon Barere, Piano. ("Simon Barere Recital") **Remington R-199-85**

*aa **St. Olaf Choir Recordings.** Olaf Chris-

www.americanradiohistory.com

tiansen, dir. (Asst. numbers). (St. Olaf College, Northfield, Minn.)

St. Olaf DLP 3 (12")
DLP 5, 6 (12")
and others.

8

*1 **Schubert, Trio in E flat, Op. 100.** Badura-Skoda, Fournier, Janigro.
Westminster WL 5121

* **Haydn, Symphonies #96, #98.** Vienna State Opera Orch. Scherchen.
Westminster WL 5111

*pr **Weber, Grand Duo Concertante for Clarinet and Piano, op. 48; Variations on a Theme, Op. 33.** Sidney Forrest, Cl., Leonid Hambro, pf.
WCFM LP-12

NEW LITERATURE

- **"The Representatives" of Radio Parts Manufacturers, Inc.,** 600 S. Michigan Ave., Room 1425, Chicago 5, Ill., is now circulating its new 1952 National Membership Roster. Copy will be forwarded to any manufacturer or distributor upon request on company letterhead.

- **Carter Motor Co.,** 2644 N. Maplewood Ave,. Chicago, Ill. has assembled complete specifications of Carter d.c.-to-a.c. converters in a new 16-page illustrated catalog which will be mailed on request. In addition to product listings, the new catalog contains the Carter selector chart, now revised over earlier editions to include the latest in TV and recording equipment. Also featured is a complete directory of Carter sales representatives. Requests should specify Catalog No. 452.

- **Tapemaster, Inc.,** 13 W. Hubbard St., Chicago 10, Ill. has produced a folder of distinct interest to tape-recordists in Bulletin No. 102, a listing of the company's new portable Model PT-125, as well as associated equipment for a variety of specific applications. Copy will be mailed free on request.

- **The Bishop Manufacturing Corporation,** 118 Factory St., Cedar Grove, N. J. includes a sample of Bi-Seal Self-Bonding Insulating Tape with each copy of a new descriptive pamphlet describing the product. Bi-Seal has many unusual properties, all of which are delineated in the illustrated folder which will be of definite interest to electronic and electrical engineers.

- **Buchanan Electrical Products Corporation,** Hillside, N. J. describes and illustrates a complete line of solderless wire connectors, cable and conduit fittings, and various wiring devices in recently-issued Catalog 52. The 12-page booklet will be of value to all professional electricians.

- **Keithley Instruments,** 3868 Carnegie Ave,. Cleveland 15, Ohio, introduces an improved instrument amplifier which greatly increases the accuracy of oscilloscopes and VTVM's in a new 4-page bulletin which will be mailed to interested persons on request. Designated the Model 102 Phantom Repeater, the instrument has input impedance of over 200 megohms, gain up to 100, and frequency response from 5 to over 150,000 cps.

- **Labelon Tape Co., Inc.,** 450 Atlantic Ave., Rochester 9, N. Y. in Folder No. 8 pictures and describes the uses of Labelon, a pressure-sensitive tape with a multitude of applications in industry. Attached to the folder is a sample of the material, described as "The tape you can write on." Copy will be sent on request to industrial concerns.

- **A-V Tape Libraries, Inc.,** 730 Fifth Ave., New York 19, N. Y. is distributing free of charge a revised and enlarged edition of its catalog of pre-recorded tape programs. The new catalog has been expanded over earlier editions to include 37 individual programs, 20 of which are in the Concert Hall series. A virtual necessity for all owners of high-quality tape-reproducing equipment.

- **The Hammarlund Manufacturing Co., Inc.,** 460 W. 34th St., New York 1, N. Y. announces publication of a new Capacitor Catalog. Available to all interested persons without charge, the detailed 2-color 12-page brochure contains complete drawings and electrical and mechanical specifications covering an inclusive selection of variable air capacitors.

Industry Notes and People--

Felix Bremy, president, Bremy Electronics, Inc., Paterson, N. J. announces plans for opening Manhattan-type Sound department for convenience of residents of northern New Jersey—will also offer complete servicing facilities—expects to be in full-scale operation by Labor Day . . . **David Sarser**, noted violinist and co-designer of the famous Musician's Amplifier, has a new gimmick up his sleeve—will admit only that it is another super-duper amplifier — first public announcement is slated for the September issue of Æ . . . **David A. Harkavy** has been appointed ad manager of Manhattan's Harrison Radio Corp.

Walter Godfrey, president, River Edge Industries, Inc., River Edge, N. J., is entering the audio market with a lavish line of equipment and speaker enclosures—moderately priced, too . . . Appointment of **Ernest Lewis Hall** as assistant-to-president has been announced by **Ben Abrams**, president of Emerson Radio and Phonograph Corp. . . . New national sales manager of Berlant Associates, Los Angeles, is **Dave Gury**, formerly manager of Kierulff & Co. sound department—will handle country-wide sales activity for Concertone tape recorder . . . **George F. Koth** recently elected vice-president of Lenkurt Electric Co., Inc., San Carlos, Calif.

Norman C. Owen named general sales manager of Webster-Chicago Corp., taking place of **W. S. Hartford**, retired . . . **Ray Laferty**, of NBC TV-development group, receiving industry plaudits for new shot generator . . . **Norman Pickering**, inventor of the pickup bearing his name, soon to begin commercial distribution of the new Pickering preamplifier, first shown at the 1951 Audio Fair . . . **Harry (RCA) Olson** made his usual hit with technical paper at the final Spring meeting of the New York chapter of the AES—soon to take off for Europe for a two month stay . . . **Lincoln Walsh**, designer of the Brook amplifier, got his dates mixed and showed up a week early for the Olson paper—out-of-town business prevented his reappearance at the correct time.

C. J. LeBel, vice-president, Audio Devices, Inc., seen exchanging thoughts with **Maj. Alexander P. de Seversky**, noted aeronautical authority, in showroom of New York's Harvey Radio Co. . . . **Norman Fyler**, formerly of Sarkes Tarzian, Inc., has joined Hytron Radio & Electronics Co., in an executive technical capacity . . . **Henry Vitarelli**, sales manager of Grayburne Corp., New York, announces appointment of **Ken Brown** as New England sales representative . . . **John H. Ganzenhuber** is new manager of government contracts department of Hoffman Laboratories, Inc., Los Angeles — formerly vice-president of Standard Electronics Corp., New York . . . Appointment of **J. C. Fink** as engineering manager of industrial products has been announced by **J. K. Hodnette**, vice-president, Westinghouse Electric Corp.

New line-up of officers of Manhattan's Hudson Radio & Television Corp. includes **David H. Ormont**, president; **Sol Baxt**, vice-president, and **Joseph Simons**, secretary—no change is anticipated in operation of the business . . . Following officers have been chosen to head up "The Representatives" of Radio Parts Manufacturers, Inc.: **Norman B. Neely**, Los Angeles, president; **Russ Diethert**, Chicago, first vice-president; **Wally B. Swank**, New York, second vice-president; **Dean A. Lewis**, California, third vice-president; **James P. Kay**, Missouri Valley, secretary, and **James J. Higgins**, Chicagoland, treasurer . . . **Jim Morelock**, chief engineer, test equipment division of Weston, has joined ranks of gentleman farmers.

ARROW EXPANDS IN AUDIO

Before many weeks have passed, music lovers (and professional engineers) in the New York area will have at their disposal a new five-story store devoted exclusively to the sale and demonstration of high-quality audio equipment.

Announced by Arrow Electronics, Manhattan jobber, the new store is located at 65 Cortlandt St., and will be operated in addition to the company's main office and wholesale operation at 82 Cortlandt St.

Plans call for complete remodelling, including air-conditioned and sound-proofed display rooms.

CLASSIFIED

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

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

FOR SALE: Complete system including four-channel preamplifier and recording amplifier, two Rek-O-Kut tables with Clarkstan arms and individual preamps. Audio Development 706A Sound Effects Filter, Presto K disc recorder, Twin-Trax tape recorder, two Shure mikes, sound effects library. Price includes all accessories, in seven matched portable cases. Full price $950.00, $300.00 down. E. H. DaCosta, RD #1, Wayne, Pa.

FOR SALE: Klipsch horn, Wharfedale driver, $125; Klipsch horn, tweeter, crossover, $250; laboratory-type Williamson and preamplifier, $85; Rek-O-Kut B5 overhead mechanism, Rek-O-Kut D16 turntable, $200; A152 Brush Soundmirror, 35 rolls tape, $100. CH 2-3226 or GR 5-5615. IAN, 125 W. 16th St., New York 11, N. Y.

FOR SALE: Concertone 1401D, NAB reel adapters. Best offer over $200. A. Yalcin, 210 Linden, Ithaca, N. Y.

ULTRA–LINEAR Williamsons with TO-300 and KT-66's, two chassis, extra power take-off, all filter and coupling capacitors oil-filled, $105. Dr. Nicely, Kenton, Ohio.

FOR SALE: Stephens 108 driver, $45; Electro-Voice "Slim-Trim" microphones, Model 655, $80; Model 654, $40. All brand new. Rauland 1825 hi-fi amplifier with front end and equalizer. Perfect condition, $60, f.o.b. New York, money orders only. R. Bennis, Box CL-1, AUDIO ENGINEERING.

WANTED: W.E. KS-12027 horn, for cash or will trade 8-cell horn with throat to fit Altec high-frequency unit. Box CL-2, AUDIO ENGINEERING.

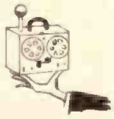
WILLIAMSON AMPLIFIER — flat 20–20,000 cycles, essentially distortionless, loudness control, $56. Long Island Sound Co., 19 Bennett Place, Amityville, N. Y.

Employment Register

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

★ Positions Open ● Positions Wanted

● **Sales Engineer.** Manufacturers! Satisfied with your sales in the Cleveland market area? Sales engineer, experienced in radio and TV sales to distributors and dealers, wants audio, radio, TV, or industrial electronics line. Capable, aggressive, promotion minded. Will answer all inquiries. R. T. Peck, 13226 Forest Hill Ave., East Cleveland 12, Ohio.



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

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

Recording Equipment, Speakers, Amplifiers, Needles, Tape, Etc . . .

BELL SOUND SYSTEMS Withdrew #2075, portable record player.

DUOTONE Added Nos. 34 through 39, Duotone display with card of Cactus needles #18 and #10. Duotone display with card of "Lifetone" Osmium tipped needles.

ELECTRO-VOICE Added model 430 utility floor stand at $10.20 net and model 423-G desk stand at $5.70 net. Electro-Voice advises that the restrictions on the use of zinc are off and that manufacturing is now underway on their full line of stands.

GARRARD SALES CORP. Withdrew crystal cartridge from 3-speed record changers RC-80C and RC-80C-DC. However, the cartridge is still obtainable in a Garrard shell as a separate item entirely. Added stylus pressure gauge at $2,50 net.

JENSEN INDUSTRIES Added Jensen sapphire needle J25LP at $2.50 list . . . added 3 replacement needles for Electro-Voice . . . 2 for Webster Electric . . . added #80, Jensen replacement needle combination at $27.88 net.

MARKEL ELECTRIC PROD. Added model 74-P at $72.00 net and 75-P at $78.66 net, both Playmaster 3 speed record changers equipped with Pfan-tone standard and microgroove high-fidelity pick-ups.

PERMOFLUX CORP. Added baffles CH-8M at $45.87 net and CH-8B at $50.70 net.

RACON ELECTRIC CO. Added CHU, high frequency driver unit . . . COB-15 and COB-16, paging speakers . . . RE-32 horn, and XP-1 and XP-2 explosion-proof driver units, both will handle 30 watts continually with peaks up to 60 watts.

RECORDING WIRE & TAPE CO. Withdrew their series of Magna-Wire & Accessories.

WEBSTER-ELECTRIC Withdrew five replacement cartridges from their line.

WILCOX-GAY Increased price on #2A10, two-speed tape recorder to $159.95 retail price.

Test Equipment

G.E. Added new Oscilloscope ST-2B at $495.00. Sugg'd user price.

SUPREME, INC. Decreased prices of d.c. microammeters models 2100, 2400, 3100, 3400, 4100 in ranges 0-50, 0-100, 0-200 and 0-500. Also decreased prices on model 3100 and 3400 d.c. voltmeters ranges 0-1. 0-3. 0-5, 0-10, 0-25, 0-50 to $9.25.

Tubes—Receiving, Television, Special Purpose, Etc . . .

DUMONT LABS Decreased prices on 12 Teletron tubes . . . added 6 new ones in 17", 20", 21" and 24" sizes.

G.E. Decreased prices on 10 TV picture tubes in 16", 17", 20" and 21" sizes.

R.C.A. Decreased prices on 20 Kinescopes in 14", 16", 17", 19", 20" and 21" sizes. R.C.A. advises of a "new kind of industrial tube price schedule—Dealer Prices—covering the 18 industrial tube types for which a two-step distribution price structure is established."

RAYTHEON Advised of 50 new special purpose tubes . . . the withdrawal of 54 . . . decrease in price of 83 and increase in price of 17 special purpose tubes. Decreased price of Rectifilter RFR-1057-BR to $50.00 user price. Also increased prices on 231 radio receiving tubes . . . decreased prices on 22 and withdrew 37 radio receiving tubes.

SARKES.TARZIAN Decreased prices on 16 TV tubes.

SYLVANIA Increased prices on Rocket tubes 2C36 and 2C37 (pulse-modulated and C.W. oscillators) to $40.65 Sugg'd resale each . . . reduced prices on Subminiature tubes 5903 through 5908 and 5916 to $13.00 sugg'd resale.

THOMAS ELECTRONICS Decreased prices on 20 Cathode-Ray tubes.

TUNG-SOL ELECTRIC Increased prices on 11 radio receiving tubes . . . decreased prices on 2 (6K8 to $2.70 list and 6L6GA to $3.20 list) . . . decreased prices on 3 CR tubes 17BP4A, 17HP4 and 17LP4 to $26.25 net each.

IF YOU ARE MOVING

Please notify our Circulation Department at least 5 weeks in advance. The Post Office does not forward magazines sent to wrong destinations unless you pay additional postage, and we can NOT duplicate copies sent to you once. To save yourself, us, and the Post Office a headache, won't you please cooperate? When notifying us, please give your old address and your new address.

Circulation Department
RADIO MAGAZINES, INC.
342 Madison Avenue
New York 17, N. Y.

MORE RELATIVE OR ABSOLUTE TRUTH

Continuing our high-fidelity reporting, the following letter has just arrived:

"I can now say I back your claims on the merits of the 215 speaker and your other equipment. All who had heard it up to a few days ago insisted it was at least the equal of the best heard down here. . . . Speakeasy members, hearing the Boffle for the first time last evening had comments ranging from "unbelievable" to "uncanny," "fantastic," "this is it," etc.

"F . . . . said his hi-fi friend, who previously tested the amplifier and preamp with his thousand dollars' worth of very fancy equipment, would certainly be at a loss for words when he comes over to hear it later in the week."

R. W. R., Chattanooga, Tenn.

In a somewhat different vein is another letter from a man who hasn't got a 215.

"I own a . . . . 3-way system using 15" woofer in folded horn corner enclosure, together with a middle and upper range driver, with crossovers at 250 and 4000 cycles.

"Quite an array! And it does sound pretty nearly perfect—but—after hearing your speaker, as a result of the tip you gave, I realize I could have done almost as well at one-fifth the cost. Your speaker is not quite as good on the low end, or as smooth on the middle range and highs as my "super-duper" system, but considering the fact that I had to pay $651.00 for mine, I feel that if I had it to do over again, I would very likely save time, space, and most important of all—money, and get your 215."

W. J. E., New York, N. Y.

We ought to say that the particular speaker Mr. E. heard is used in a bedroom tucked away in a convenient small space, and it is also not our very latest model, which latter has an even better response. Yet under those conditions, and costing only $54.00, it tends to hold its own against the most expensive installations. This has only become possible because our ideas on speaker design are quite different from others.

* * * * * * * *

Our catalogue is free for the asking, and a comprehensive technical report on the speaker is included. But if you want to get in closer touch with our quite revolutionary ideas on sound service, enrol in our data service for the total cost of one dollar bill. You will be told what a Speakeasy is, what it can do for you, and how your hobby of audio can also be turned into something very lucrative.

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

ADVERTISING INDEX

PARTRIDGE WILLIAMSON OUTPUT TRANSFORMER

Built to the original specification

De-luxe model now available from stock from all important Radio Stores throughout the U.S.A. (Price $26.00 duty paid)
This transformer is now accepted as the most efficient in the world. According to "Audio Engineering" (Nov. 1949), there is no U.S. equivalent. Thousands already sold in the U.S.A.
Partridge P.1292 16 watt Output Transformer now available is intended for use in equipment reproducing the full audio frequency range with the lowest possible distortion.
Series leakage inductance .10 mh.
(Price $21.00 duty paid.)

The Following Stores are among those now Stocking Partridge Transformers.

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

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

Sun Radio Corp.,
938 F Street, N.W.,
Washington, D. C.

Gates Radio Company,
Quincy, Illinois.

Terminal Radio Corp.,
85 Cortlandt Street.
New York 7.
Gates Radio Company.
2700 Polk Avenue,
Houston, Texas.
Wholesale Radio Parts Co. Inc.
311 W. Baltimore St.,
Baltimore 1, Maryland.
Sole Agents in Canada:
Atlas Radio Corporation,
560 King Street West,
Toronto 2-B.

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

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

PARTRIDGE TRANSFORMERS LTD.
TOLWORTH, SURREY, ENGLAND

OFFICIAL RECORDER OF 1952 OLYMPICS

1952 Olympic Games

TWIN-TRAX*

Selected in International Competition by the Olympic Purchasing Commission

Because of their quality, dependability and exceptional value, Twin-Trax* Recorders were selected *exclusively* for all recording and rebroadcasting of this year's Olympic Games. Engineers of Finland's Purchasing Committee circled the globe while visiting every manufacturer of tape recorders and testing their products. They chose Twin-Trax* to guarantee perfect recording, and give them maximum value for their money.

You, too, can own a Twin-Trax* Recorder, discriminately chosen for the greatest recording project of all time. As a Twin-Trax* owner, you will be in good company — with thousands of government agencies, broadcast stations, schools, and critical music lovers who have also made Twin-Trax* their "official and exclusive" recorder.

*Trade Mark Reg.

Write today for Catalog #5324, containing complete specifications and direct factory prices.

AMPLIFIER CORP. of AMERICA
398 Broadway New York 13, N. Y.

www.americanradiohistory.com

METERS ARE ACCURATE...

TALK IS NOT...!

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

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

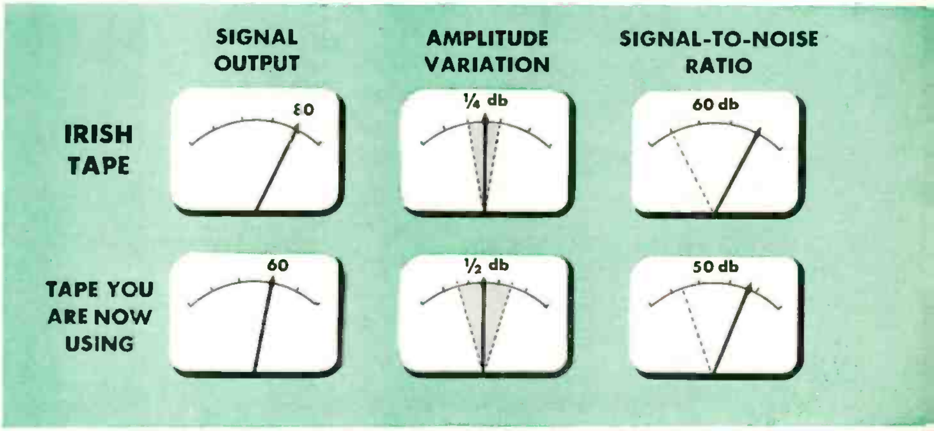
MAKE THIS ABSOLUTELY FOOL-PROOF TEST BY ACTUAL METER READINGS:

① Splice end-to-end, **ORRADIO IRISH BRAND** 211 RPA with any conventional tape you may be now using.

② Record a 6000 cps audio signal through the splice from **ORRADIO 211RPA** to the "comparison" tape.

③ Rewind and play back with your VU meter across the output.

THE DIFFERENCE WILL BE STARTLING!



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

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

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

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

The Reason?

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

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

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

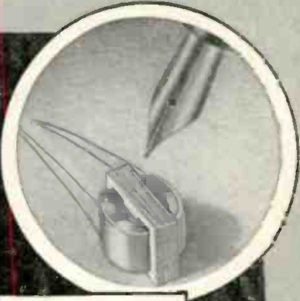
Manufactured in U.S.A. by

ORRADIO INDUSTRIES, INC. OPELIKA, ALABAMA

World's Largest Exclusive Magnetic Tape Manufacturer

FOR MINIATURIZATION

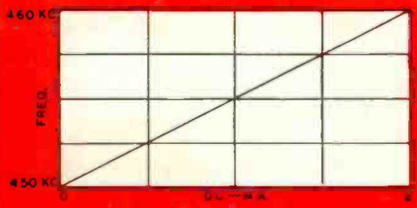
The miniaturization of transformers has been a UTC specialty ever since the development of the Ouncer series in 1937. The importance of this engineering "know how" is reflected by the large number of UTC Miniature components in present military equipment. Some examples of this engineering leadership are illustrated below.

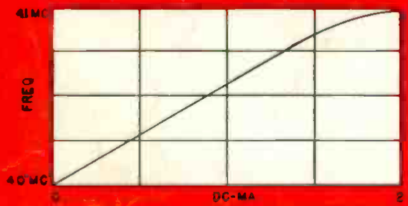


SM Unit ACTUAL SIZE — As photographed with normal pen for comparison.

DC CONTROLLED OSCILLATOR INDUCTORS

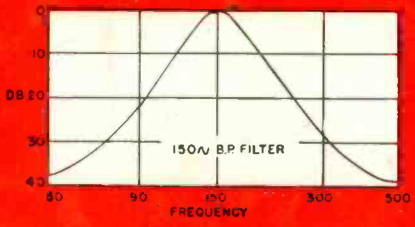
The curves below illustrate oscillator frequency variation using two types of RF inductors varied by the amount of DC through the controlled windings. These units are available in ouncer size and smaller.

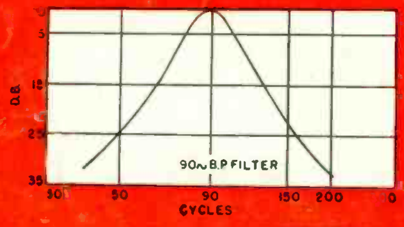




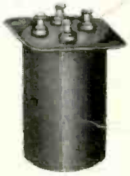
MINIATURIZED AIRCRAFT FILTERS

The standard 90-150 cycle aircraft filters have been reduced in size and weight in UTC's miniaturization program. The curves below illustrate the frequency characteristics of these units.



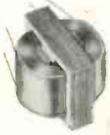


Ouncer case, non hermetic, is ⅞" diameter x 1⅛" height. Weight — .06 lbs.



Ouncer case, hermetic, is 15/16" diameter x 1⅜" height. Weight — .11 lbs.

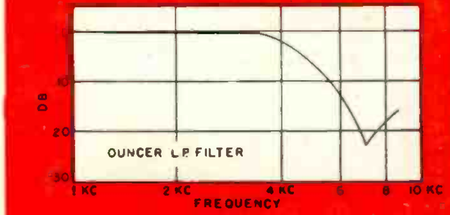
Miniaturized filter case is 1 11/16" x 13/16" x 1⅝" height. Weight — .3 lbs.

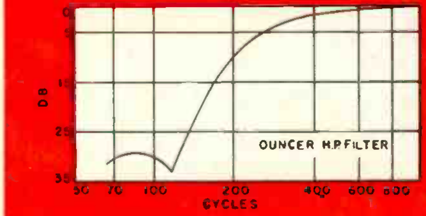


SM sub-miniature audio components, 7/16" x ½" x 7/16" height. Weight — .009 lbs.

OUNCER FILTERS

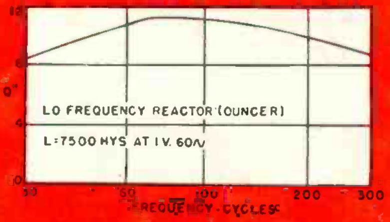
Filter miniaturization is a specialized art. The curves below show a low pass filter and a high pass filter being supplied in the UTC ouncer case.

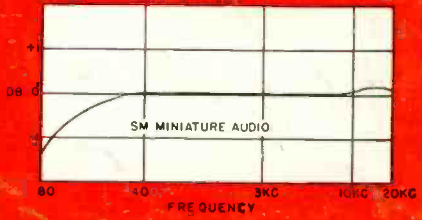




EXTREME MINIATURIZATION

Through the use of specialized materials, extremely compact designs are possible. The curve below illustrates the Q characteristics of a 7500 hy. low frequency reactor housed in the UTC ouncer case.





The sub-miniature audio transformer whose frequency curve is shown above, weighs less than one-seventh of an ounce yet provides wide range frequency characteristics. Its impedance ratio is 500 to 50,000 ohms for operation into a ½ meg. loaded grid.

United Transformer Co.

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