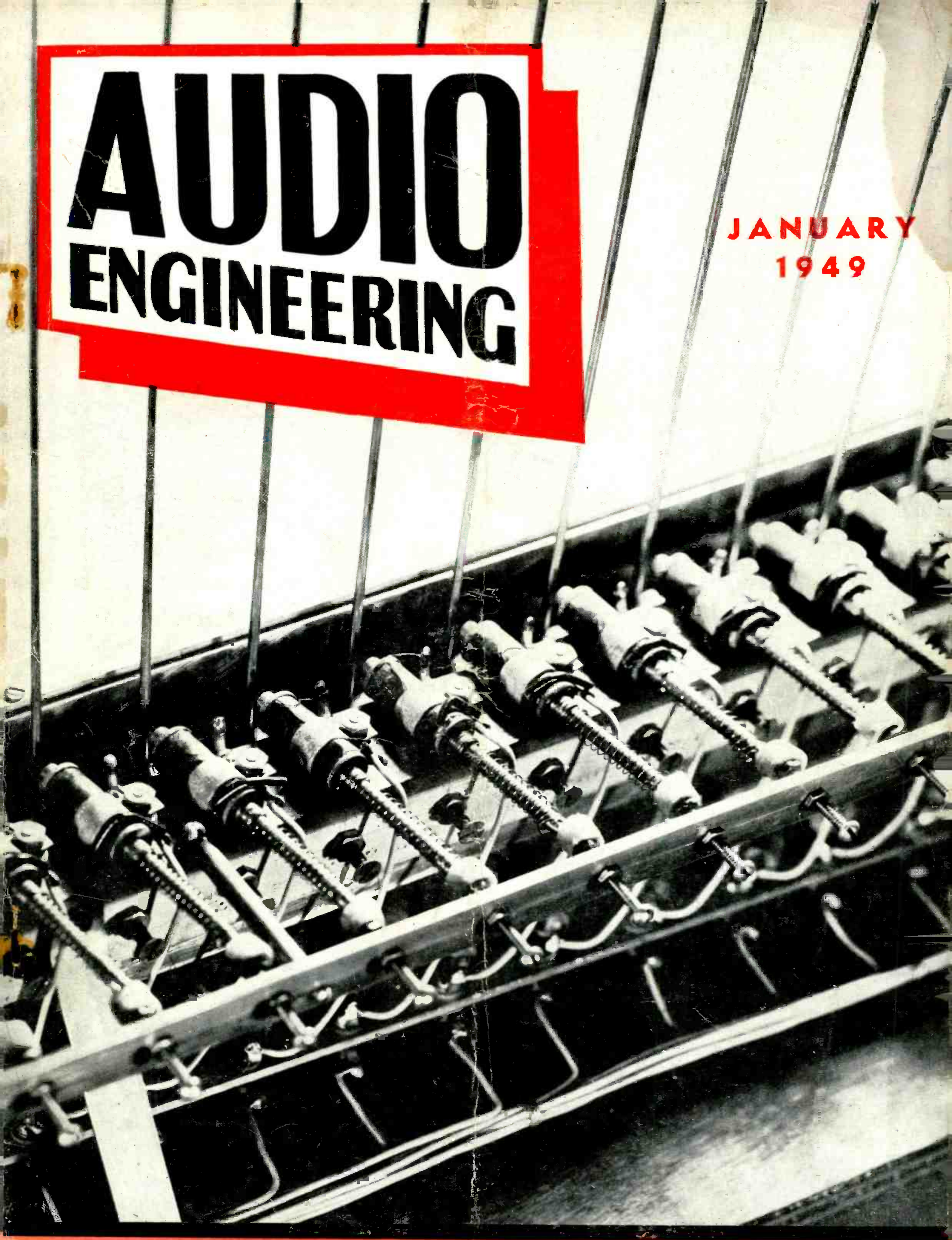
AUDIO ENGINEERING

JANUARY 1949



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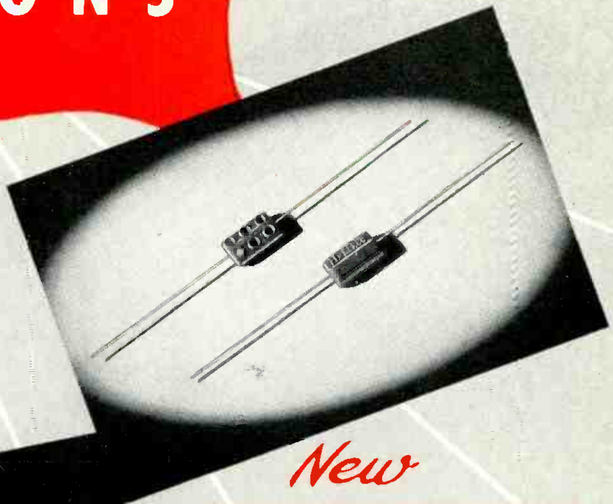

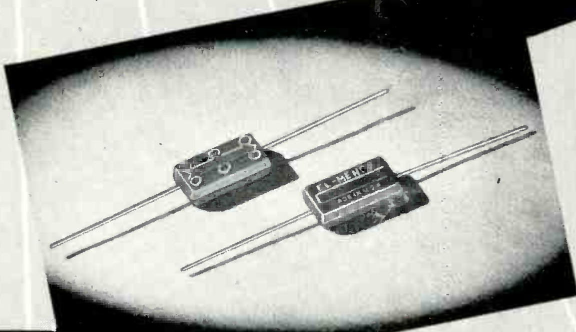

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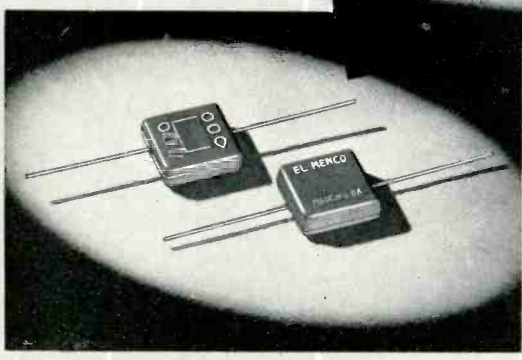

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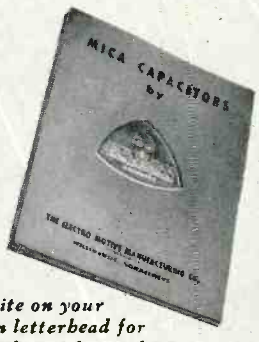

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816 W. 5th St., Los Angeles 13, Calif.

Dale International Publications, Ltd.
105 Bolsover St., London W. 1, England

Harris & Floyd, 297 Swanston St.
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Established 1917 | CONTENTS | JANUARY, 1949 | Vol. 33, No. 1

COVER

Tone generating apparatus for electronic chimes designed by Finley Berry of New York.

AUDIO ENGINEERING (title registered U. S. Pat. Off.) is published monthly at New York, N. Y., by Radio Magazines, Inc., J. H. Potts, President; Lawrence LeKashman, Vice Pres. Executive and Editorial Offices at 342 Madison Avenue, New York 17, N. Y. Subscription rates—United States, U. S. Possessions and Canada, $3.00 for 1 year, $5.00 for 2 years: elsewhere $4.00 per year. Single copies 35c. Printed in U. S. A. Entered as Second Class Matter July 29, 1948 at the Post Office, New York, N. Y., under the Act of March 3, 1879.

EDITOR'S REPORT

AUDIO FALLACIES

ONE OF THE MOST persistent fallacies which plagues broadcast audio engineers concerns the width of the sidebands transmitted when using amplitude modulation. Some time, somewhere, someone cooked up a story that AM broadcast stations are limited to a 10-kc channel and, to avoid interference with one another, the audio sidebands therefore had to be limited by the F.C.C. to 5,000 cycles. Consequently, what's the use of designing radio receivers with an audio system capable of handling higher frequencies when they aren't being broadcast? Unless, of course, we are picking up FM, which goes up to 15,000 cycles.

This old wives' tale is absolutely false. Most of the major stations in large cities are equipped to broadcast up to 10,000 cycles, and even to 15,000 cycles, using amplitude modulation. In fact, the F.C.C. standards for good operating practice for AM stations actually require every AM broadcast transmitter to provide a frequency response characteristic flat within 2 db up to 10,000 cycles. Actually, not only are the studio and master control equipment of a good many stations better than this, but also the remote pickup lines for local programs. Only for programs originating in other cities, where long lines are used, is the frequency range less.

The idea that high-quality audio systems are worth while only for FM is thus likewise untrue. Fact is, Armstrong invented FM primarily to reduce noise caused by atmospheric disturbances; not for higher quality audio reproduction. Not that we wish to minimize the importance of FM; far from it. Radio receivers are designed to be listened to, and if the reception is marred by noise, who gives a whoop about frequency range? But we do want to stress the point that wide-band transmission is available on AM as well as FM.

Another point: why so much attention to the higher frequencies while the lows are ignored? If the audio response peters out somewhat above 7,500 cycles, but is clean, the lost octave between 7,500 and 15,000 cycles will not be greatly missed on most programs. Of greater importance is the octave between 50 and 100 cycles where all sorts of methods have been devised to jack up the response cheaply, and usually unsatisfactorily, as well as calming down loudspeakers, which often pass through resonance within this range.

This floundering around basic audio problems, and the widespread ignorance of present-day broadcasting practices among radio set designers, were particularly obvious at the Rochester Fall Meeting of the I.R.E. last November. The newly formed audio group within that organization presented a symposium entitled, "What Constitutes High Fidelity?" The speakers were two officers of the Audio Engineering Society and a past president of the Acoustical Society. The I.R.E. itself has never gone in heavily for audio, leaning more to the r-f end, where a degree of proficiency in juggling Bessel functions can sometimes be utilized, and makes articles more impressive. As a result, many of the questions from the floor showed that a goodly proportion of the audience had little or no knowledge of what has been going on in audio during the past decade or so. One set designer was quite astonished to learn that station WHAM, right in the hotel where the convention was held, was putting out up to 15,000 cycle modulation on their AM signals, as well as for FM. And there are many more doing likewise.

Better audio systems in radio receivers are long overdue and may soon become an economic necessity. Even for TV, where the novelty of being able to see via radio (for a very substantial consideration) has created a tremendous demand for the necessary apparatus, better audio will soon be needed to keep sales going. People get tired sitting in one place over long periods to watch what's going on. But they can always listen: and they will if the sound is good.

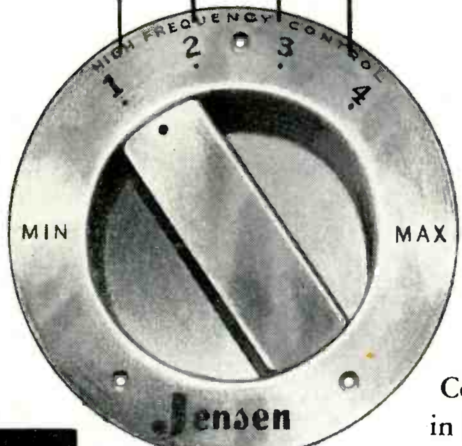
—*J.H.P.*

2. for average "AM" Broadcast

3. for High-quality "AM", "LP" Records, and Transcriptions

1. for some Phono Records and "SW" Broadcasts

4. for "FM" and Television Sound



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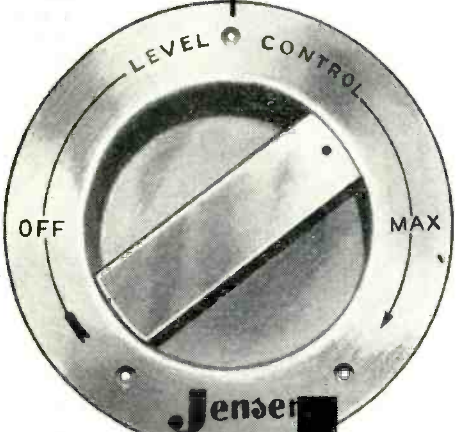

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— Letters —

Psycho-Acoustics

Sir:

Although it seems that you have already decided to keep TV out of your magazine, may I express my view about this matter? Please keep AUDIO ENGINEEING *audio only.* If, however, the scope of the magazine is to be enlarged in any way, there is one other branch of the audio field which I would like to see included. Could you publish some articles devoted to psycho-acoustics? Admittedly, the relationship between the physical aspects of sound and the psychological (and physiological) aspects of hearing is complex, but the very complexity of this relationship should be a challenge to men of authority in the audio field. AUDIO ENGINEERING could perform a fine service by bringing to focus for its readers the real nature of this branch of audio.

True, Canby, in his "Record Revue", occasionally offers a bit of food for thought in this area, but such instances seem more accidental than intentional. Bomberger's article on equal loudness control systems (May '48) recognizes a very fundamental "defect" in the physiology of hearing. It seems to me that this factor has far too often been ignored by devotees of the "flat to within plus or minus 1 db, 20 to 20,000 cycles" philosophy. White has reported an interesting experiment in binaural hearing (July '48) which we intend to set up here at the University of Washington Speech Department. As a problem in research, we may be able to shed some light on the "phenomenon" of which he speaks.

In other words, AUDIO ENGINEERING has not altogether omitted this (I believe) all important factor, but some real contributions in psycho-acoustics will not only be very interesting to many of your readers, but it might even open the eyes of some of our excellent "audio" (circuit) men to new horizons.

But as far as this subscriber is concerned, let's leave RF, FM, and TV to the publications which are now handling them. AUDIO ENGINEERING can best serve the area below 20,000 cps by staying below this figure.

James L. Shapley,
Associate, Speech Department
University of Washington,
Seattle 5, Wash.

Speaker Housings

Sir:

On this occasion of the start of the second year of our subscription to AUDIO ENGINEERING (we have just received your "acceptance" card) I should like to say how very much I have enjoyed the copies we have so far received, it most certainly is the ONLY mag for the sound man. You cover the subject very well indeed but personally I should like to see more space devoted to the ever important subject of loudspeakers and their housings. I should also like to see actual basic design data on real HiFi amps., such as choice of phase

[*Continued on page 34*]

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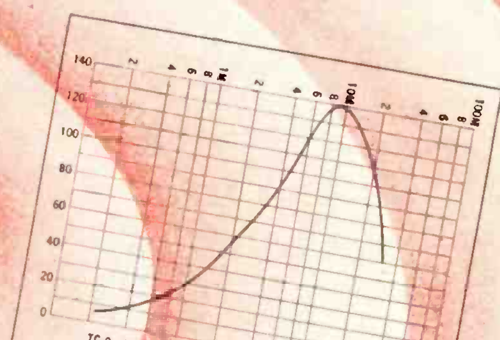

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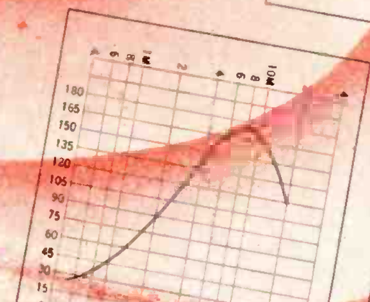

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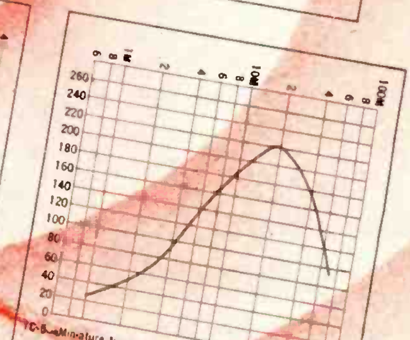

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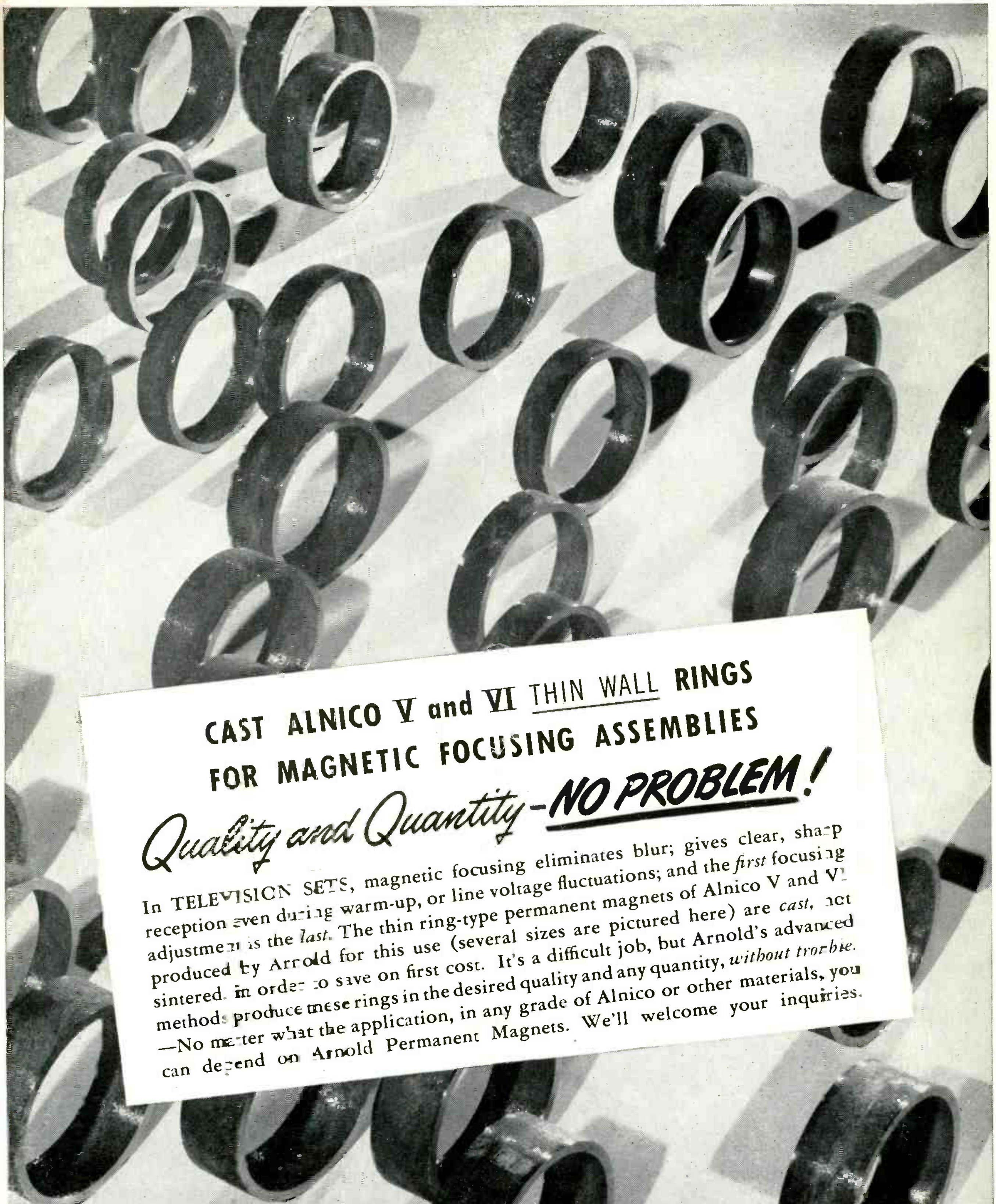

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Psycho-Acoustic Aspects of Higher Quality Reproduction

C. J. LeBEL*

The author emphasizes the commercial advantages of better reproduction.

THIS IS A DELIBERATELY CHALLENGING PAPER, for wide attention to better sound quality in the home is at least ten years overdue. It will stress the beneficial commercial effect of improved sound quality, because that most important feature has been generally overlooked.

The radio field has been badly confused over the public's reaction to higher quality. The incorrect idea that extended frequency range and high quality are synonymous has caused much of the confusion. A further source has been the fact that many of the factors lie in the semi-subjective field of psycho-acoustics. The typical set designer or chief engineer is generally a radio-frequency engineer with no feel for the subjective, and hence is easily misled. As Ben Olney has often said, the average set designer thinks of it only as a device to join a signal generator to an output meter. Such few organizations as have maintained a staff of audio engineers, *with adequate authority*, have found the result profitable.

Listener Fatigue

That listening may cause fatigue is a matter which has had little engineering attention. There has been a limited amount of unpublished work, and one or two magazine articles, on the subject, but it has never been discussed before a learned society.

The fatigue effect results after a listening period of a few minutes to a dozen hours. It is a fatigue of the understanding centers of the brain, not of the cochlea in the ear, and ranges from the mildest weariness to one so extreme as to force an immediate respite. There has been some effort to blame such weariness wholly on program character, but experiment leaves no doubt that system characteristics are equally effective.

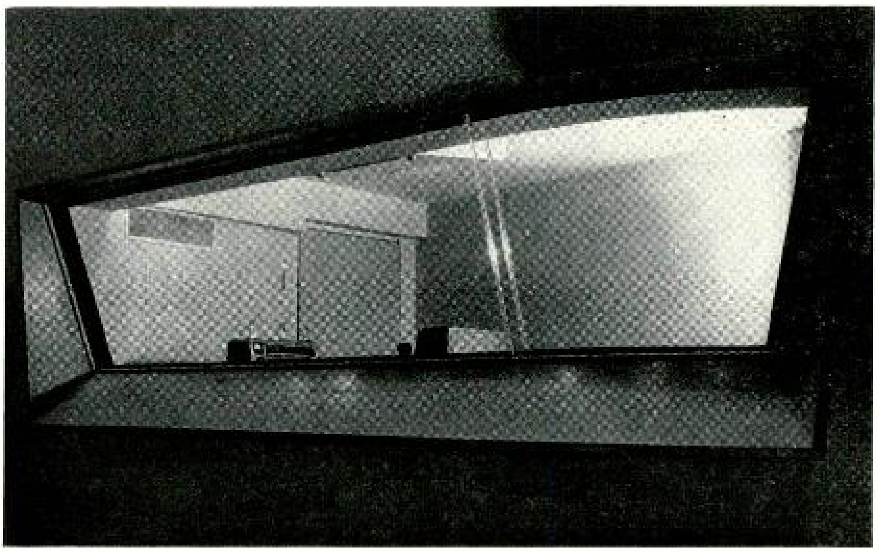
Reduced-Fatigue Designs

In prewar home radios the low, medium and high priced fields each had one manufacturer whose designs were definitely less fatiguing than those of his competitors in the same price class. All three makers were very successful. Much of their success was due to aggressive selling, but we have the word of an experienced merchandiser that their easier listening led to repeat business over a period of more than fifteen years. The fatigue effect of most radio sets cuts listening time which reduces the business of radio stations and tube manufacturers. In fact, it has been proposed that NAB and the tube manufacturers grant a subsidy to makers of sets which have exceptionally low fatigue effect in their respective price classes.

In the hearing-aid field we have interesting observations which are applicable to other fields as well, for approximately one-half of the hard of hearing have hearing characteristics very much like the normal except for a sensitivity reduction which is essentially uniform with respect to frequency. It has been demonstrated that a drastic reduction in fatigue effect, with no visible change in the instrument, may double sales within a period of months. In one case, ten thousand dollars' worth of engineering was as effective as several hundred thousand dollars' worth of advertising. Such a high ratio of yield is probably due to the fact that the average hearing aid user wears the instrument twelve to sixteen hours a day, and the resulting fatigue, with a poor design, can easily be beyond human endurance.

Motion picture theater owners have known for years that the public will go to some little trouble to avoid poor sound, as reference to the *SMPE Journal* will indicate. Few engineers realize that the theater owner's success depends on giving an *impression* of spending money with reckless abandon, whilst

A view from a Columbia Broadcasting System studio into the associated control room. The clean-cut design of the double glass observation window (which is typical of this network's studio design) provides excellent unobstructed vision between the two areas. The glass is set at carefully determined angles in order to avoid all possibility of any reflections that would hinder vision to the slightest degree. It is interesting to note that because of this slope, the curved, by-window-like end sections require especially fabricated glass. Rather than being simply sections of cylinders of proper radius, they must be particular sections of accurately dimensioned cones.



Audio Devices, Inc., 444 Madison Ave., N. Y. C.

actually purchasing with great care. Hence it is significant that you will find no theater with equipment as bad as the average home radio set.

In the disc field, the influence of sound quality is mingled with the effect of an artist's fame and the vogue for a particular selection. It is the duty of the musical director and the artist to avoid a head-on comparison of technical quality undiluted by artistic considerations, but nevertheless it is recognized that good sound quality is one of the factors which affect record sales.

The inexperienced observer's reaction to sound quality of reduced fatigue factor shows his appreciation of better presence: "It sounds very natural", "the announcer sounds right here in the room", "this is very easy to listen to", "you can listen all day without getting tired", "it sounds so clear", are commonly used phrases.

Fatigue Testing Methods

There has been no prior discussion of fatigue testing methods before a learned society, and so a brief statement of these methods may be of interest. They are subjective methods — you may as well be warned in advance. Subjective does not mean qualitative, for the results can be reduced to rough quantitative relations.

The most accurate results can be secured in the hearing aid field. A series of identical-units, matched as to all performance elements except the one being tested, are given to a skilled but non-technical observer. One or two standard production units are always included as controls. Each instrument is worn several days, then the best two are worn for two days each. Instruments may be listed in order of performance under any given condition. If very poor units are being compared, or very sensitive observers used, the measure of performance is the consecutive number of hours the unit can be worn before fatigue compels shutting it off. Better units are compared on the basis of the amount of fatigue after a normal period of use. It is wise to diversify the type and degree of hearing loss when picking such a jury, for some are abnormally sensitive. For instance, certain nerve type cases were unable to wear a once very popular low-priced unit for more than an hour before fatigue became excessive.

Results from such tests correlate well, and it is possible to predict accurately the public's reaction to a new model on the basis of three sets of curves and a listening test. The listening test is intended to evaluate the effect of mechanical noises — particularly case, clothing, and cord noise.

Radio sets are no easier to study. Good designs may require a week of listening to evaluate, while mistakes may be rejected in one evening. A chance for direct comparison is also desirable if the models to be compared are unusually bad or unusually good. This places the evaluating burden upon a trained listener, usually an engineer. That the method can be successful is shown by the number of companies which have been able to turn out superior product by this means.

The motion picture field has relied on the trained listener also, for many years.

While comparing some 16 mm sound projectors intended for the educational market, it was found that student attention was direct function of reduction in fatigue. Even the most interesting films cannot hold the student if the reproduction is bad. Without verbalizing the matter very much, educators have been conscious of the need for good quality sound in both projectors and educational recorders.

Fatigue Factors

We now examine the fatigue factors in detail, realizing that noise is the worst. Different fields find different noise sources their main problem. In hearing aids, case vibration, clothing rubbing across the microphone opening, and cords rubbing on the clothing and body are of major importance. Tube microphonics can be objectionable if not guarded against.

In home radios, natural and man-made static are made more serious by the vogue for built-in antennas. The use of narrow band width is largely prompted by the discomfort caused by wide band reproduction in sets as ordinarily installed.

In phonograph work, record scratch has been a great deal more serious than it need be. Quieter pressing stocks have been available for years, but their universal use waits upon more intense competitive conditions than presently obtain.

Harmonic and intermodulation distortion have a strong fatigue effect which can be somewhat minimized by reduction in frequency range. Articulation tests do not provide a good index because they are generally carried on for too short a time. Most radios marketed today distort a great deal more than they need to for a given manufacturing cost. American records often have much higher intermodulation distortion than desirable, due to polishing and over-use of stampers. In this connection it is interesting to note that Roys[1] has shown that intermodulation is greatly increased by polishing, but that harmonic distortion is not significantly affected.

The mere raising of the upper cutoff frequency to 8,000 cycles is not in itself a guarantee of improved quality. The lower cutoff must be reasonably placed, and there should be no gaps in the response. The following efforts were labeled "high fidelity" some years ago, but they were still very unsatisfactory to listen to: One had response limits of 300 and 8,000 cycles; another had limits of 100 and 8,000 cycles with a gap between 2,000 and 4,000 cycles, and a third had limits of 100 and 7,000 cycles with strong peaks at 200 and 1,000 cycles. Peaks, valleys, unbalanced limits are all annoying to the ear.

The dynamic characteristics of a transducer are not always the same as the static characteristic. As Shorter[2] has shown, a loudspeaker may behave quite differently when handling interrupted tone than when handling steady tone. Many of us have had the experience of having a loudspeaker sound differently from what its response curve would indicate, and this work of Shorter's provides the explanation. Peaks so produced are ruinous to "presence", and have a strong fatigue effect. Loudspeaker manufacturers have often put peaks in the response, feeling that it was an inexpensive way of adding lows, or highs, or loudness efficiency to satisfy the set manufacturer. This has done more to impair radio receiver quality than almost any other defect.

While discussing dynamic characteristics, it might be well to note that microphones of nominally identical response but different construction may produce rather different sound — a matter which seems to have been given no engineering study. Other transducers may have a similar fault, though for better understood reasons. For example, a phonograph pickup which is not tracking properly will sound very unpleasant even though the nominal characteristics seem normal.

In a system with low distortion the result may be very fatiguing if the frequency range is not great enough for good presence. Good speech through a 2,000 cycle cutoff system can be understood for a while, but becomes painful in time.

Some Remarks on Testing Procedures

There is great need for getting down to fundamentals in the matter of testing procedures. All that have been reported have involved a series of multiple choice tests, with the procedure entirely beyond the control of the subject, and with no satisfactory explanation of what was going on. We may term this the "confused reaction". Unfortunately, radio set tone controls are not set by a series of multiple choice tests. The user handles the control himself, and he hears the effect as he changes it. Cause and effect are always obvious, and he has a much clearer understanding of the whole matter. We may term this the "considered reaction". The dealer may even make some educational comment on the effect of the control in question. It is perfectly true that the confused reaction is much easier to elicit, and that group testing is much cheaper. On the other hand, the greater significance of the individual test would seem to compel its use, if only for validating purposes.

In setting up a test, be sure that the program source is suited to the work. Only Olson[3] has paid attention to the acoustical conditions of the studio and the listening space. In Chinn and Eisenberg's work[4], for example, we are informed only that studios were used for each. But the standard broadcast studio is, intentionally, very bright. To originate and reproduce under the same abnormal conditions will produce an abnormal result. Increased band width makes exacting demands on every part of the system. Any study in which the acoustical conditions are not well defined is likely to lead to an inaccurate conclusion.

Be sure that program balance is correct for the band width employed. A large number of programs are acoustically balanced to sound well through a $19.95 mantel set, and when exposed to a wide range system the results are very painful. A similar problem is that of choosing the proper equalization in reproducing phonograph records. It is impossible to accept the results of a record test unless data on the equalization, pressing stock, amount of previous use of the records, etc., are supplied. The only published study of this nature is notably deficient in its facts, but the many unpublished studies seem to be equally faulty.

It is particularly necessary to be sure that the program material is as free from distortion as possible. Because of faulty processing many phonograph records have a great deal higher intermodulation distortion than would be indicated by measurements on the recording equipment alone. For example, one manufacturer's lacquer originals show three to four per cent intermodulation, while his production pressings run ten to twenty per cent. This is not necessarily characteristic of all American recording today, but it is typical of a certain class of organization. Pickups are a prolific source of distortion when abused, or when the stylus tip becomes worn. Receiving set demodulators are another potential source of trouble. Set designers have paid too little attention to this problem, so rigorous tests must be made before a tuner is used for listener preference testing.

Some programs do not require wide range to give excellent presence. The accordion is an excellent example of such a source. Other programs that do require wide range for presence, may irritate the listener so much that he prefers narrow range reproduction to ease the pain of listening. Certain ultramodern forms of music unquestionably fall in this class. Therefore, it is a wise precaution not to attempt to test the popular music devotee with the three B's or vice versa. This is a legitimate restriction because each will normally listen only to his own preferred type of music.

One type of test, which should be more often considered, is that in which the response curve is shaped. We listen to a set at a rather lower acoustic level than that which exists in the auditorium or dance hall, and it is well known that this forces the ear to operate over a different part of the Fletcher-Munson curves[6], so that it loses low frequency sensitivity. A certain amount of bass boost is therefore reasonable. Likewise, it is not necessary to eliminate the higher frequencies to reduce the offensiveness of a small amount of distortion. A small amount of high frequency attenuation is quite effective. There is a certain tendency, amongst those with just enough knowledge to handicap them, to criticize high frequency attenuation as a fatal defect. The contrary is true. A few db of attenuation do not shift a tone below the threshold of hearing; they merely reduce its importance to the whole. We regard this expedient as an excellent interim way to render slightly distorted wide band reproduction more palatable.

Difference Limens

Gannett and Kerney made a study[5], of the discernibility of changes in program band width, which should be read by everyone interested in listener preference testing. Their tests were made with experienced listeners, and were designed to measure solely the ability to *discern* a change in band width with no question of preference involved. In testing with ordinary unskilled listeners, with both discernibility and preference involved, we would expect a less certain reaction in all cases. If we find a more certain reaction by unskilled listeners, then we may fairly conclude that there is something wrong with the program material in the tone band which is being thus forcibly rejected.

In order to compare the Gannett and Kerney results with those of Chinn and Eisenberg, it is necessary to simplify the latter's figures. Chinn and Eisenberg permitted a listener vote for either band width, and also a vote of no preference, whereas Gannett and Kerney permitted only an opinion on which of two band widths was being presented.

A vote of "no preference" is rather indefinite, it can mean either that (1), the listener could detect no difference or (2), the listener could detect the difference, but found both presentations equally acceptable. It is fair to assume that if the "no preference" choice were eliminated, those who had previously so voted would have to choose one of the remaining groups by guessing—which would put half of their votes in each group.

If we apply this technique to Chinn and Eisenberg's 5000 versus 8000 cycle test pair, we get the following orthodox

[*Continued on page 32*]

This group-accommodation studio "C" 26' x 40', is located on the ground floor of KOMO'S new broadcasting station, directly adjacent to the central operations corridor, which is entered through the door in the right background.

HEAD ALIGNMENT

With Visible Magnetic Tracks

B. F. MURPHEY* and H. K. SMITH*

It is reasonably obvious that, in order to obtain optimum results in magnetic recording on tape, it is necessary to align the recording and reproducing head gaps to a certain degree of parallelism. In order that tapes recorded on one machine may be reproduced on another without loss of high frequencies, it is necessary that the gaps be made perpendicular to the edge of the tape. An easy technique has been developed to obtain these alignments which seems to be worth calling to the attention of audio engineers.

The first order approximation for amplitude loss due to skewed gaps is reviewed, and a technique for microscopic examination of the recorded track is described.

Theory of Alignment

Schott[1] first discussed the effect of nonparallel gaps in magnetic recording, although certainly the equivalent situation in photograph recording received prior attention. Imagine a line gap which is within an angle α of being exactly perpendicular to the motion of the tape. It is possible to compute the ratio of the voltage induced in a misaligned head to the voltage induced in a perfectly aligned head. The calculation, given in the appendix, leads to the following result.

$$E_{\alpha_{max}} \Big/ E_{o_{max}} = \frac{\sin\beta}{\beta}$$

where $\beta \cong \pi\alpha\, d/\lambda$

The width of the tape is denoted by d and the wavelength on the tape by λ.

From these equations we may predict a decrease in output for a misaligned head which is greater, the greater the gap length d, the greater the angle α, and the smaller the wavelength λ. *Fig.* 1 illustrates the effect to be expected for certain practical values of these constants.

Table 1 shows the values from which *Fig.* 1 was plotted.

From a plot such as this, values for other wavelengths and gap lengths may be obtained readily. For instance, the effect of doubling d is the same as doubling α, while doubling λ is equivalent to halving the angle α. *Table II* lists the value of α required to give certain attenuations for various values of d and λ in use today.

If we assume that a given method of slit alignment will assure accuracy of perpendicularity to within an angle of plus or minus δ, the alignment which assures interchangeability of tapes between machines is obviously $\delta \leq \alpha'/2$ where α' is the angle for the the permissible attenuation. From *Table II* it is seen that δ for 1 db attenuation must be less than 4′ 30″ in cases 1 and 2, less than 3′ 36″ in case 3, and less than 2′ 15″ in case 4. For constancy of reproduction to within 0.5 db, these values of δ are not halved but multiplied by 2/3, since the curve of *Fig.* 1 is not linear.

TABLE I

	$d = 0.1''$	$\lambda = .001''$
α	Sin β/β	db Loss
2′	.993	.07
4′	.978	.18
10′	.865	1.3
20′	.531	5.5
30′	.141	17
34.5′	0	∞

A method is described in the following section which allows for adjustment of alignment to within a half db in cases 1, 2, and probably 3; to within 1 db in cases 1, 2, and 3, and probably case 4.

Microscopic Technique

Visual examination of the track recorded on magnetic tape may be carried out in a manner analogous to the mapping of magnetic fields by means of iron filings. Using suspensions in ethyl acrylate of Fe_2O_3 particles about 1 micron in diameter, Bitter[2] obtained the first pictures of the domain pattern on a ferromagnetic surface. A similar method has been used before to make the pattern associated with

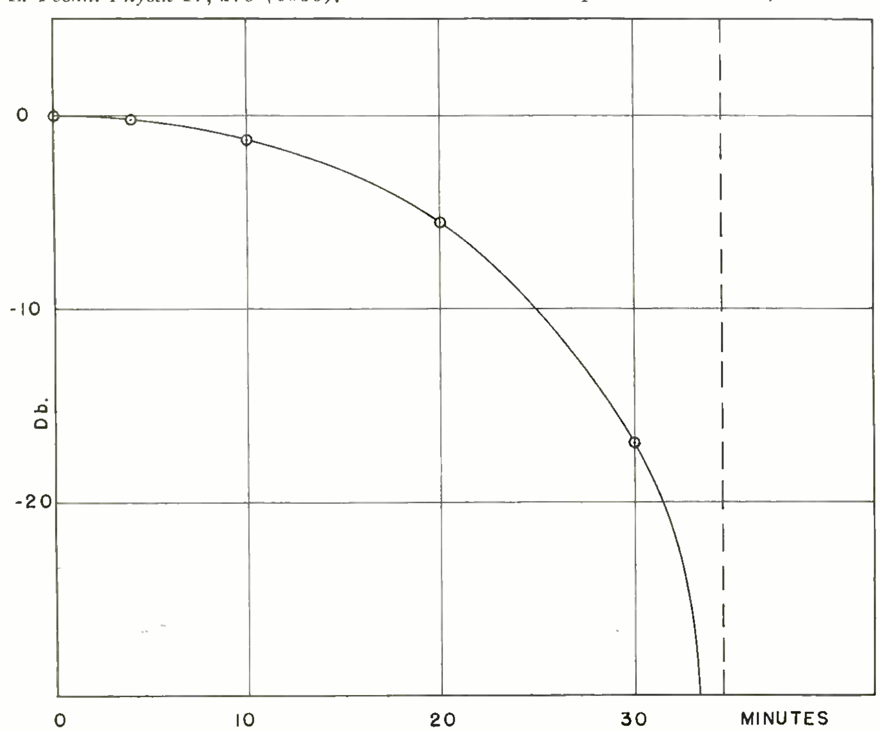


Fig. 1. Db loss versus α in minutes of Arc. $d = 0.1$ inch, $\lambda = 0.001$ inch.

*Minnesota Mining and Manufacturing Co., St. Paul, Minn.

[1]Z. Techn. Physik 17, 275 (1936).

[2]F. Bitter, Physical Review 41, 507 (1932)

the track on magnetic tape visible. The process consists simply of covering the surface of a magnetic tape recorded to saturation with an oil suspension of Carbonyl Iron particles. There appears, almost at once, a series of straight lines at right angles to the length of the tape which is visible to the naked eye. Photomicrographs of typical patterns are shown in *Fig. 2.* Wavelengths as short as 0.001 inches have been examined where the alternating poles are one-half mil apart.

The materials used for producing a visible pattern of the recorded signal on magnetic tape vary. Black magnetic oxide of iron, gamma ferric oxide, or iron powder may be used. These should be very fine particles, 3 microns or less, and dispersed in a liquid which does not evaporate readily and which has a sufficiently high viscosity to prevent flocculation. Flocculation, to any great extent, interferes with the sharpness of the lines and consequently with the accuracy of the measurements. The powder selected should give as much color contrast as possible with the tape being used. Carbonyl Iron of about 3 microns diameter made by General Aniline Company, Grasselli, New Jersey, having a grey color which reflects light well, has given very satisfactory results when mixed with raw linseed oil or a mineral oil such as "Nujol".

Using this method of making the track visible, the process of alignment of magnetic recording heads is as follows: A saturated signal of one mil wavelength is recorded on the tape. A portion of the tape is covered with the oil suspension of Carbonyl Iron and examined by means of a microscope provided with cross hairs and a rotating stage in order to determine whether or not the lines corresponding to the recorded track are perpendicular to the edge of the tape. Adjustment of the head, recording and microscopic examination of the track are repeated until the track is aligned within the desired angle.

Once the recorded track is correctly oriented, the recording head is obviously aligned. To adjust the reproducing head, a long recording is made at the highest frequency the system is designed to produce. A meter is connected to the output of the system and, using the long recording, the reproducing head is adjusted to give maximum output. From the theory of misalignment, it is apparent that the greatest sensitivity for adjustment is found at the shortest wavelength.

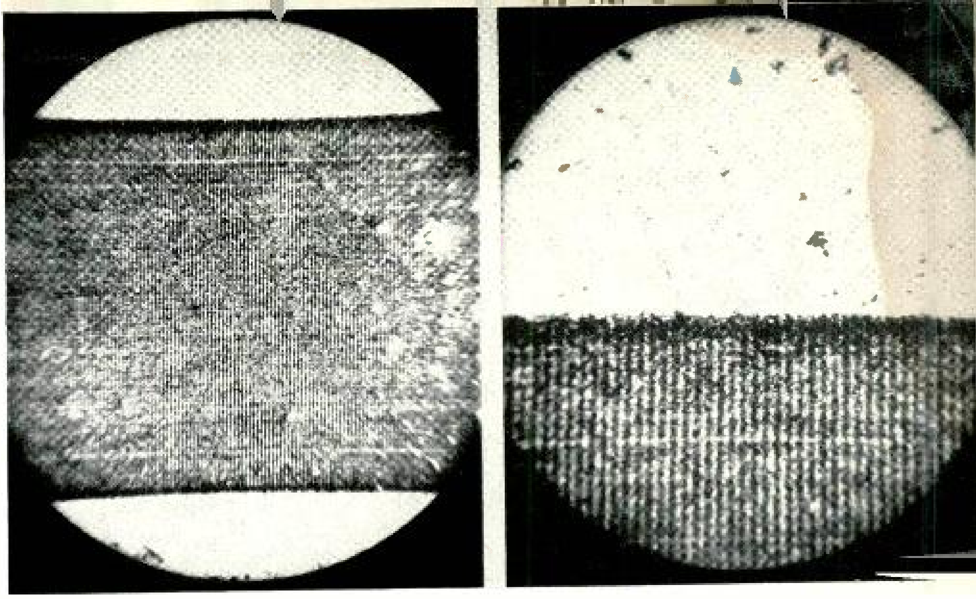


Fig. 2. 0.0023 inch wavelength signal at magnifications of about 20X and 60X.

TABLE II

Case	d	λ	f in cps	V in./sec.	α' for 1 db att.	α' for .5 db att.
1	0.1"	.001"	7500	7½"	09'	06'
2	0.2	.002	9000	18"	09'	06'
3	0.25	.002	15000	30"	07' 12"	04' 48"
4	0.25	.00125	12000	15"	4' 30"	3' 06"

We were required to align a set of heads which fitted the conditions of Case 1, *Table II.* The microscope used was provided with a carefully centered rotating stage and a vernier attachment graduated to 03'. A 28 mm. objective and a 12.5X eyepiece gave ample magnification. The stage was shifted until the horizontal cross-hair fell on the track edge, then the vertical cross-hair was used to measure the angle of the recorded pole[3].

If pains are taken to make the length of the tape parallel to one of the motions of the stage, then the stage motion at right angles may be used to follow the track across the tape. The alignment can then be checked by observing the fraction of a track width that the tape is misaligned. Knowing this, the wavelength and width of the track, the angle of misalignment may be computed.

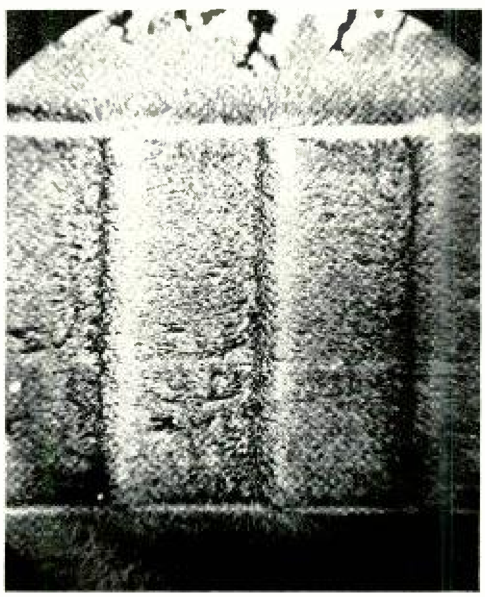
Centering the track edge in the field avoids the "pincushion" effect so apparent in *Figure 2a.* With this equipment it was relatively easy to obtain track perpendicularity to less than 0°03'.

For measuring the angularity of the recorded signal, a magnification of about 30 to 40 times is all that is necessary. A greater magnification than this leaves such a short part of the recorded signal in the field of view that accuracy of measurement is reduced.

The visual examination of the track not only provides a means of aligning tape, but also reveals peculiarities in head construction. In *Fig. 2* for example, there appear streaks along the length of the recording. Gaps between laminations will show up in such a manner, but will be much more pronounced. In one instance the gap of the record head was made as small as possible by removing the foil. Upon examining the track recorder from this head, it was found that each lam-

[*Continued on page 38*]

Fig.3. 92 mil wavelength signal, magnified approximately 20 times.



[3]Instruments such as the Gaentner Coordinate Comparator, which may be adjusted to a smaller angle, 01', might also be used. Some limitation on the method is imposed by slight imperfections along the edge of the tape and by lack of definition of the track.

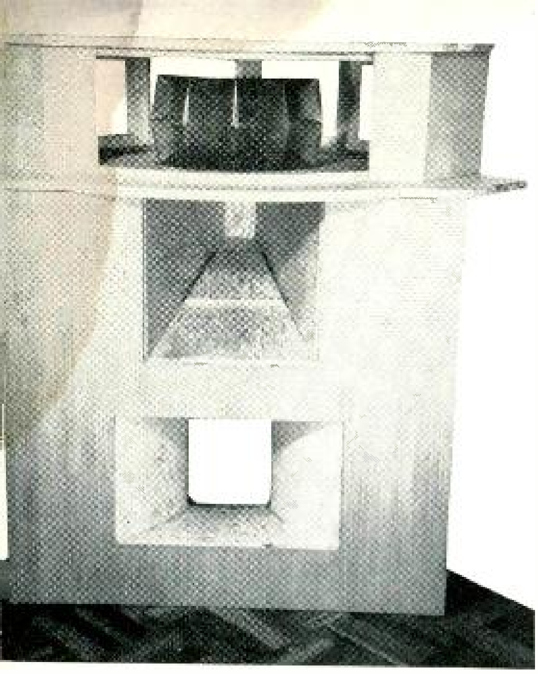


Fig. 3. Front view of the new speaker during construction, showing the speaker well and the TV tube enclosure.

A New Corner Speaker Design

C. G. McPROUD*

A new speaker cabinet designed to accommodate television in addition to providing high-quality sound reproduction.

*"Trifles make perfection;
but perfection is no trifle."*

WITH THIS TRITE SAYING as the guiding maxim in the construction or assembly of a high-quality reproducing system, the experimenter strives constantly to achieve perfection in the whole by working toward perfection in each separate component. In the past few months, the writer has endeavored to delineate the steps taken to arrive at the best possible reproduction from the electrical circuits of a residence radio system. Not that the equipment described is the only solution to the overall problem—far from it—but it is one solution designed to provide the maximum of convenience in operation together with a reproduction quality which leaves little to be desired.

Now that television is firmly established as a home entertainment medium, a *complete* installation must necessarily contain TV facilities, without sacrificing the superb quality desired for radio and phonograph reproduction. And, of course, no mention was made in the previous series of the loudspeaker to be used with the residence system. Therefore, solving two problems at once, the TV installation has been combined with the loudspeaker in a form which results in high-quality reproduction, a reasonable compactness, and a piece of furniture which is an eye-appealing addition to a modern living room.

Basic Design

It has been fairly well established that the most efficient location for a loudspeaker is in the corner of a room. The most outstanding example of this arrangement is represented by the Klipschorn, which consists of a two-way speaker system with both high- and low-frequency units being horn loaded. The cabinet work for the Klipschorn is extremely complicated, and certainly not one which the amateur woodworker should attempt. Some constructors have mounted a multiplicity of medium-quality cone speakers on the two sides of an obtuse enclosure, such as that shown in *Fig.* 1, and used this arrangement in a corner with excellent results. The corner location is optimum from the standpoint of loading on the speaker, since the radiation is over only half the angle of that from a speaker mounted on a flat wall. With a number of ordinary cones, the result is a means for moving rather a large volume of air without the necessity of having a large cone excursion of a single unit. Thus, better low-frequency response is obtained with speakers which individually would not perform so satisfactorily.

The writer has long used a standard two-way speaker of conventional design, and while the reproduction quality has been considered excellent, the low-frequency output did not compare with that of a good theatre system. Thinking from this point, the next step appeared to be in the direction of a corner speaker, yet utilizing the reflex action of a vented cabinet. Basically, therefore, the new design occupies the corner of a room, and is arranged so that the vents are loaded by a horn comprised of the walls and the sides of the cabinet enclosure. The plan view of the cabinet is shown in *Fig.* 2, with the vent openings *A-A'* along the sides. Thus the vents are loaded by the straight-sided horn between the wall and the cabinet.

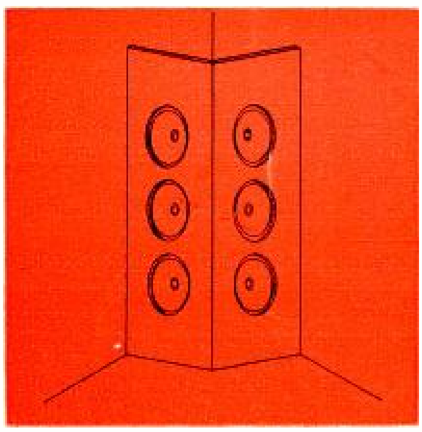


Fig. 1. Mounting a number of ordinary cones on two sides of an obtuse structure for corner use is one solution to the necessity for moving more air.

Experience has shown that loading of the vents should be accompanied by a similar loading on the direct radiating side of the low-frequency speaker, so the front of the cone is provided with another horn section, *B*, thus equalizing front and back loading and increasing the radiation efficiency. A top for the cabinet provides an air seal by means of gaskets between it and the wall, and the floor provides the other horn wall for the vented ports. The entire cabinet is open to the back, and utilizes the room corner, although if desirable for use in other locations, a false corner could be constructed to provide the necessary back.

After determining the basic design, any necessary variations can be made to accommodate TV, as has been done in this case. The picture tube is simply enclosed in a wood housing, and doors in the cabinet front cover the screen when it is not being used. The superstructure, shown in *Fig.* 3, houses the multicellular high-frequency horn and unit, and the space behind is large enough to accommodate the TV receiver chassis. With such a construction, the picture tube is between the two speaker sections, and the illusion of sound coming from the picture is considerably better than if the speaker is either

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above or below, or at the side of the screen.

Development of the practical aspects of the construction is controlled by the units selected for both high- and low-frequency speakers. In order to get the best possible low-frequency reproduction, manufacturers' catalogs were studied, and the cone selected on the basis of power handling ability and natural resonant frequency.

Good speaker performance depends on a number of factors. Among these is a high gap flux, which should be as great as possible. A high field strength ensures good damping as well as the maximum of efficiency. Another important factor is the relative weights of the cone itself and the voice-coil structure. It is considered good practice—for good low-frequency reproduction—to have these two weights as nearly equal as possible. It is also important to have as low a resonant frequency as can be obtained readily.

The low-frequency cone selected for this system is a 15-inch model, rated at 20 watts, and with a resonant frequency of 42 cps. This model is the Stephens P52Lx—the *x* denoting a special model of the more-common P52Y—designed for the woofer of a two-way system, and having straight cone sides and a lower resonant frequency than the standard model. Another important feature is the special treatment of the cone rim to prevent reflections from the frame. Good results may be expected from any of the high-quality 15-inch speakers available, such as the Altec-Lansing 803A or the 515, or the Jensen PLM-15A or P15-NLA models, but the lower resonant frequency of the Stephens model governed the final selection for this particular application.

The selection of suitable high-frequency units is slightly wider. Ready-made are the Stephens P15 unit and the 824 horn, with an 800-cps crossover; the Racon RABAT unit with a two-cell horn designed for a 1200-cps crossover; or the Jensen P8-151 horn with an XP-101 unit. The Atlas HF-1 is also usable, but if this choice is made, the low-frequency cone should have an impedance of 8 ohms to match the dividing network which is supplied. The unit installed in the complete speaker shown is an Altec-Lansing Model 901B, of early vintage, but still quite satisfactory. The horn is a 2x4 multicellular type, built by the writer, and previously described in these pages.[1]

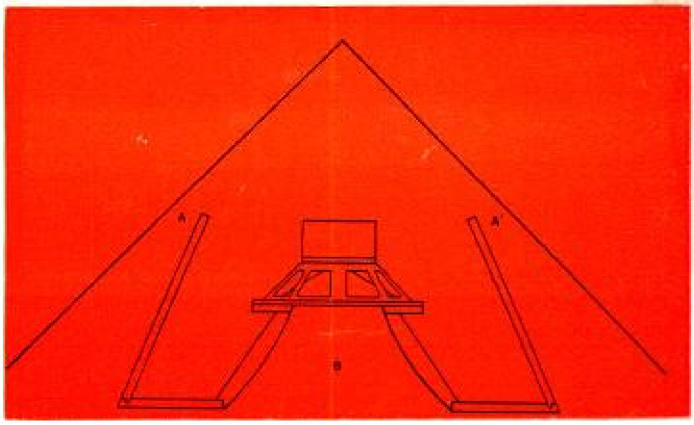


Fig. 2. Plan view of the new corner speaker design, showing vents at either side between the cabinet and the wall, and the horn loading provided by the wall and the cabinet sides.

Construction Details

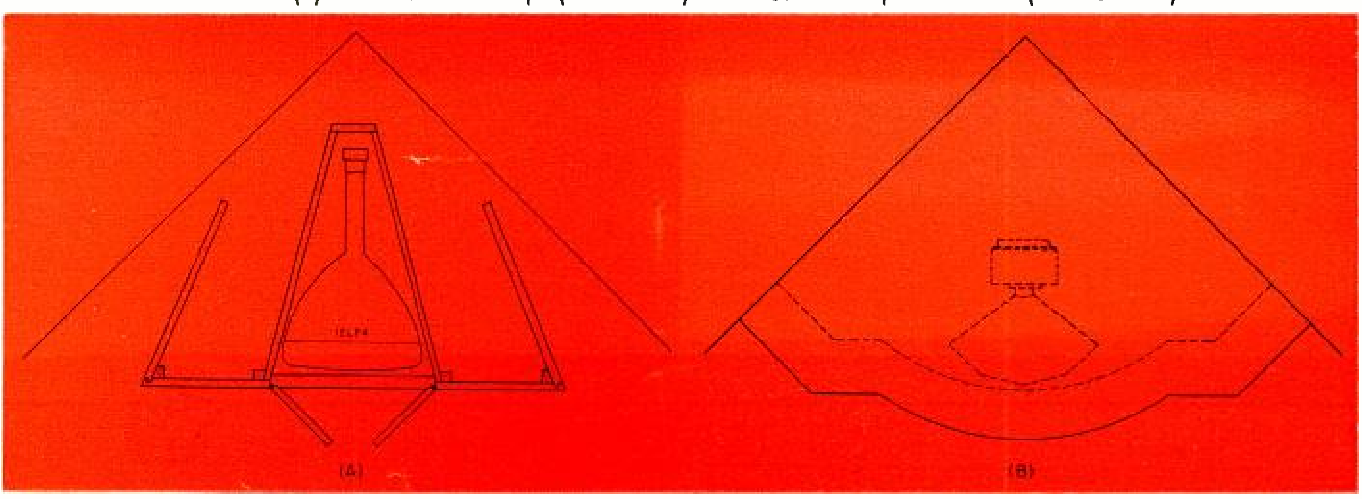
Getting down to a specific design, therefore, the cabinet takes the shape shown in *Fig.* 2 for a cross section at the plane of the low-frequency cone, and at (*A*) of *Fig.* 4 at the plane of the center of the TV picture tube. The top of the low-frequency cabinet has the outline shown in the solid line at (*B*), with the superstructure shown by the dotted lines. The top is 39 inches from the floor, and the corners of the top meet the side wall 36½ inches from the corner. Allowing for the volume of the speaker well and speaker and of the tube enclosure, the net volume of the cabinet is 8.5 cu. ft. This does not include the vent horns, which are usually included in the volume when vent pipes are used on the reflex ports.

Figure 5 shows the major parts used in the assembly of the low-frequency portion of the speaker, together with the housing for the picture tube. It will be noted that there is a hand hole in the bottom of the tube enclosure, with a removable cover which serves two purposes: it mounts the deflection yoke, and thus permits adjustment of the TV receiver with the tube removed from the cabinet; and it also permits anchoring the cabinet to the corner of the room by means of a pair of steel cables and two turnbuckles. The cabinet is placed close to the corner, and with the turnbuckles open to their maximum, the cable is looped over a hook mounted on the floor right in the corner. Then the turnbuckles are tightened up, thus locking the cabinet into the corner with the top tight against the wall. The quarter-inch semicircular groove along the back edges of the top provide space for a gasket to make an airtight seal. When the hand-hole cover is replaced, the structure is airtight except for the vents.

The wood selected for the top and

[1] *Winslow, "Two-Way Speaker System,"* AUDIO ENGINEERING, *Nov. 1947.*

Fig. 4. (A) Cross section of the cabinet at the plane of the center of the picture tube to show location of tube enclosure. (B) Plan of the top (solid lines) and of the superstructure (dotted lines).



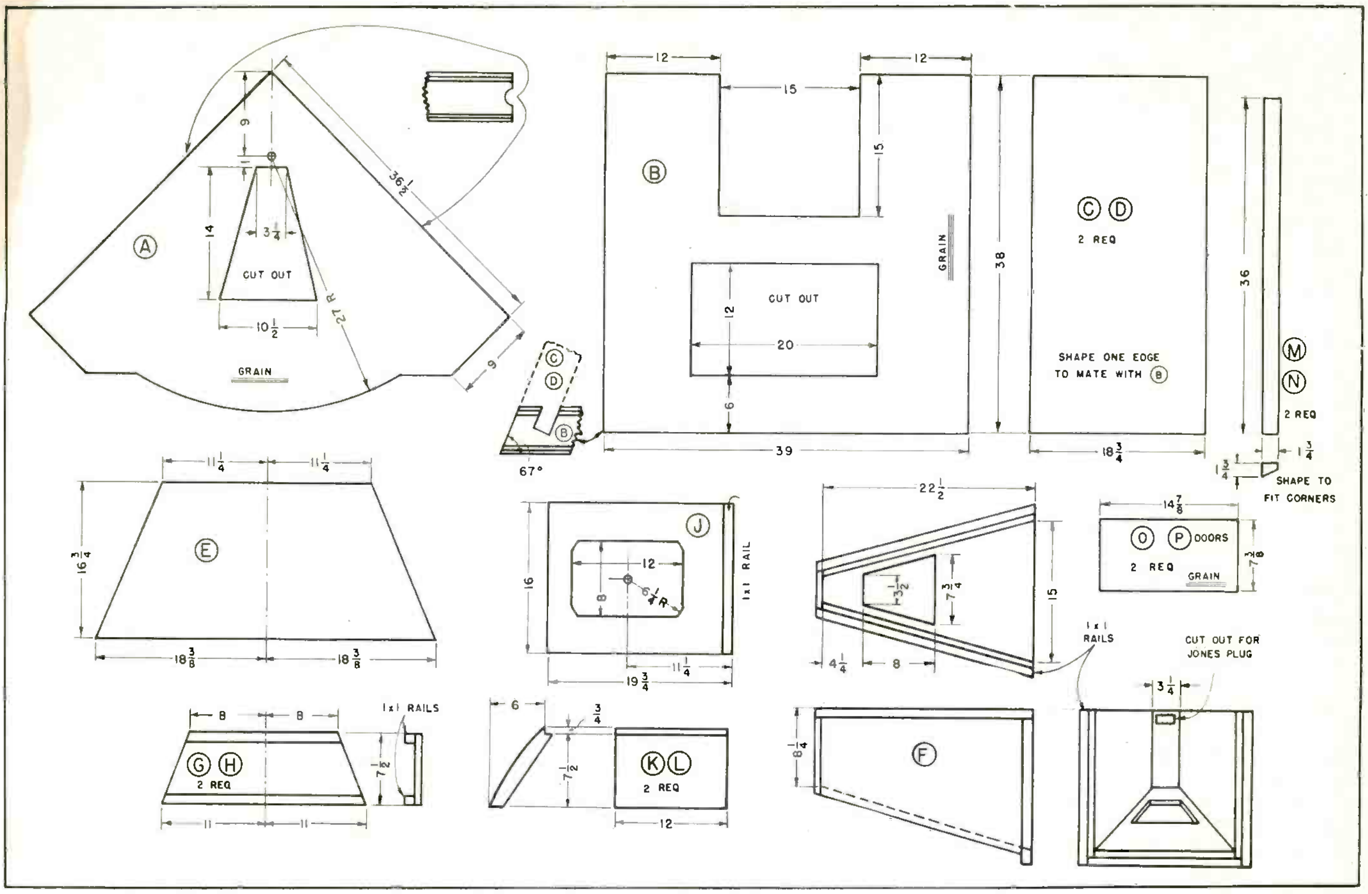


Fig. 5. Details of the pieces which comprise the lower cabinet, speaker well, and tube enclosure.

front of the cabinet should be a suitable match (or contrast) for the furniture used in the room where the speaker is located. For solid contsruction, ¾-in. material is recommended, with veneered hardwood being used for the top *A* and the front *B*. The doors *O* and *P* should be solid, or else veneered on both sides. The bottom *E*, sides *C* and *D*, speaker baffle *J*, and the tube enclosure *F* can be of less expensive fir plywood, also ¾-in. thick. The tube enclosure is a part of the acoustic chamber, which accounts for its seemingly over-solid construction.

The sides, *K* and *L*, of the speaker well are shaped from two-inch white pine, and should be fitted to the opening in the panel. The speaker baffle is drilled with eight holes, and T-nuts for mounting the speaker are installed on the front before the "horn" is assembled. In addition to the pieces shown, a number of ¾ x ¾ strips will be needed for corner reinforcement. Parts *M* and *N* are for the acute corners at the front of the cabinet.

The details of the superstructure will be described in next month's issue, and the parts are not shown in *Fig.* 5. However, it might be well to plan on another veneered piece nearly as large as the top *A*, since the grain should run parallel with the front of the cabinet, as shown by the shading lines. The two tops will cut readily from one panel of hardwood veneer.

Since this speaker is supposedly "functional," no attempt is made to disguise its appearance. The front of the low-frequency cone is visible in the speaker well, or horn, being protected by a screen of expanded metal. The inside of this horn is finished in dark blue lacquer, as are the sides of the cabinet and the edges of the two tops. The front and the top, together with

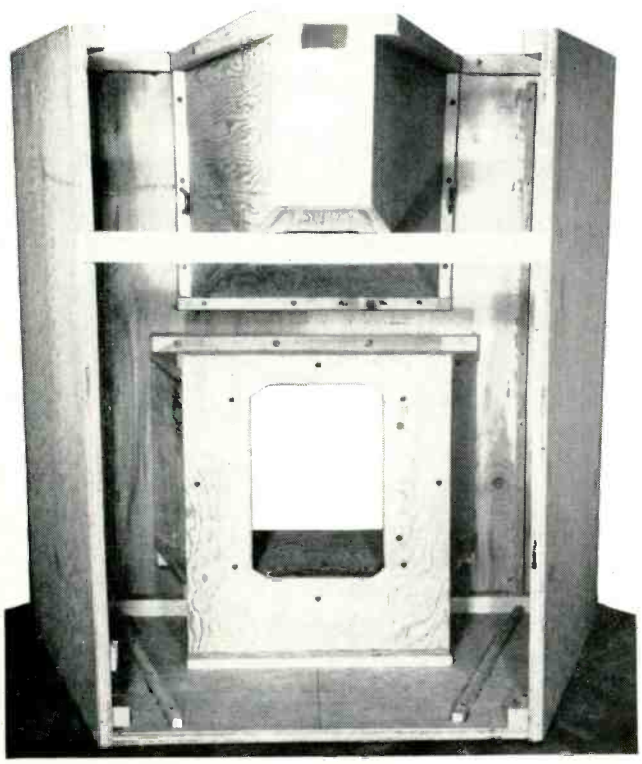


Fig. 6. View of the rear of the lower cabinet showing method of assembling the various sections.

the superstructure, are bleached oak, as is the tube mask. Lacquer covers the jointing of the speaker well to the panel, as well as the non-veneered edge of the top. If a uniform hardwood appearance is desired, the edges should be veneered—a job best done by the cabinet maker who cuts the pieces out. One caution is necessary—make sure that the top will fit the corner tightly. *Not all rooms have 90-deg. corners.*

Assembly

Once all the pieces have been cut out, the next step is that of assembly. Since some of the operations appear to be tricky, it is well to follow a certain procedure to avoid having to put the last few screws in with an offset screwdriver. The first step is to assemble the speaker well, which is a short exponential horn. Parts *G* and *H* are mounted on part *J*, using the shaped sides as spacers. Remember to put the T-nuts in place on the baffle before attaching the other parts. All joints should be glued, preferably with casein glue, and secured with 1¼—12 flat-head wood screws, countersunk. This assembly should then be attached to the front panel, also with glue and wood screws. The shaped sides, *K* and *L*, are then fitted into place, also with glue and screws. Every joint in the cabinet is made with both glue and wood screws except that between the top and the lower section. This facilitates moving the entire unit. The top is attached only with screws, so it may be removed to enable the cabinet to pass through a 30-in. door.

After the speaker well is completed, the bottom is attached to the front, using a ¾-in. strip at the joint. The front extends clear to the floor, to eliminate the extra construction necessary for a recessed base. The bottom is thus inset, since the sides also extend to the floor. After the bottom is attached to the front, it is also secured to the speaker baffle. Next the corner braces are attached to the front, and the strips along the lower edges of the sides are screwed in place. ¾-in. up from the edge. The sides are then fitted into the groove in the front panel, and all joints screwed together. The tube enclosure is next mounted to the front, and supported at the back with a cross brace. The entire structure should now resemble that shown in *Fig.* 6, which also shows the ½-in. square furring strips for the sound-deadening lining.

At this point, the doors should be fitted, using ⅜-in. Soss invisible hinges which are mortised into the front and the doors. These hinges are the least obtrusive of any hinge available, and while they are a little difficult to mount, the final appearance warrants the extra effort.

Electrical Connections

To avoid external wires, some provision must be made to introduce the signal and an a-c line to the unit, since it will not be readily accessible once the cabinet is mounted in place. The power circuit is necessary for the TV chassis, as well as for a possible outlet for a lamp or clock as an ornament on top of the speaker. Since the speaker is designed to work from a radio-phono system housed elsewhere, the speaker signal must also be fed in. This is done at a small panel located just inside the lower right corner of the cabinet. One three-way male receptacle is used for speech, and a two-way male twistlock receptacle is used for the a-c line. The speech circuit goes to a switch which selects radio-phono in one position, or TV in another, and with an off position—the unused inputs being properly terminated. The output of the switch then goes to the dividing network, mounted on top of the speaker well, and thence to the two speaker units. Access to the high-frequency unit is had through an 8-terminal Jones receptacle, which also receives the input from the TV receiver and carries the a-c line up to the superstructure. This receptacle is mounted at the back of the tube enclosure, and permits removal of the top without disconnecting any wiring. The electrical circuits are shown in *Fig.* 7.

Preliminary Finishing

After the lower section is completely assembled, it should receive its first finishing operation. To protect the surface of the wood, the interior and the bottom should be given a primer coat of lacquer or some other undercoat. All cracks in the exterior should be filled with plastic wood, and the rear corners of the speaker well should be rounded out with fillets of the same material. After thorough sanding, the sides and the speaker well should receive a coat of an undercoat such as Firzite, which is an excellent filler for plywood. Finishing of the hardwood exterior should wait until the superstructure is completed in order that the two sections match as well as possible. Since most of the work on the lower section is now complete, the padding may be tacked in, using large-headed nails to prevent tearing out. Ordinary rug padding, such as Ozite, appears to be satisfactory for this purpose, although rock wool or Fibreglas is recommended by some constructors. The possibility of the fine glass shredding around a speaker cone argues against the use of either of the latter insulating materials, and the Ozite appears to do a satisfactory job of deadening without this risk. It is desirable to use two thicknesses over the larger areas, though the furring strips provide a good absorptive covering since there is an air space behind the padding.

In the next article of this series, the superstructure details will be described. While this cabinet design is intended to include TV, there is no reason why

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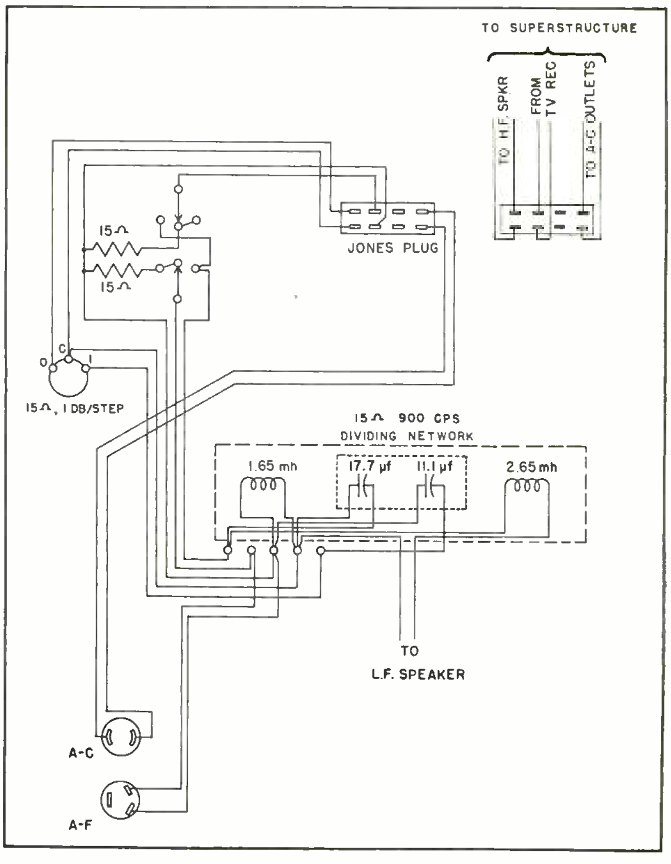

Fig. 7. Wiring diagram of the lower cabinet.

Motion Picture Film Sound

H. D. HASTINGS* and T. F. LoGIUDICE**

Broadcast engineers contemplating the installation and operation of television facilities are introduced to a newcomer. This article deals with the measurement and maintenance of its sound head mechanism and associated audio equipment.

A GOODLY PERCENTAGE of the broadcast time of television stations presently consists of transmitting motion picture film program material. It is both convenient and economical to record short commercials, news-events, playlets, etc., on film to be broadcast at any time that it is desirable to do so. The television broadcaster has also found that full length feature "movies" add interest and variety to his program schedule, and current trends seem to indicate that film will be put to more extensive use in future television program planning.

As transcription facilities are to audio programming, so may be the role of film projection equipment to television programming.

For the technical staffs of audio stations currently installing, or planning to install television equipment, it is worth while to become acquainted with motion picture sound reproducing equipment.

Current Audio Practices

The broadcast engineer has realized for a long time the importance of maintenance routines aimed at preventing equipment failures and inferior performance due to improper adjustment. In audio work this preventive maintenance usually takes the form of

1. Performance measurements.
2. Repair and adjustment.

The first may be periodic comparison of his equipment, unit by unit, with manufacturer's specifications by audio-frequency performance tests. Or the engineer may prefer to check his equipment over-all from microphone amplifier input terminals to line amplifier output terminals in accordance with approved conditions and techniques.[1] The second phase consists of tube and part replacement, cleaning and adjusting as a result of irregularities discovered by these tests.

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**Sales Manager, Arlington Electrical Products Co., N.Y.C.

Similar procedures may be used in the maintenance of television film projectors, more particularly with the sound-head, with which this article is concerned.

Sound-Head Mechanism

An optical sound-head is shown on *Fig.* 1, which consists of an exciter lamp, optical system, a rotary-stabilized drum over which the film passes as the sound track is scanned, a photo-tube and coupling circuit to the first

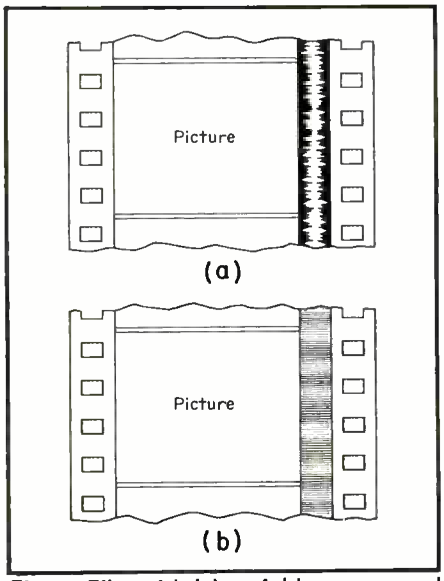


Fig. 2. Film with (a) variable area sound track and (b) variable density sound track. Both are in general theatre use.

stage in the audio amplifier. The optical system is usually enclosed in a tube which contains lenses that focus the image of the exciter lamp filament on the plane of a slit. Following the slit, other lenses focus the image of the slit upon the sound track of the film as it passes by the scanning point. There are two types of photographic sound records in general use known as variable area and variable density. These are shown in *Fig.* 2. In both cases the light passing through the film is modulated by the sound track and the resulting change in photo-tube current is amplified. Most motion picture sound reproducing equipments permit adjustments in the sound optical system in the following ways:

1. Movement of some of the elements in the optical system to permit the focusing of the light beam on a plane of film.
2. Movement of the optical system in a lateral, or left to right, direction in order to center the light beam properly on the sound track.
3. Adjustment of the optical system so that the image of the slit is perpendicular to the path of film travel. This is called the azimuth adjustment.
4. Adjustment of the exciter lamp position in order to obtain a uniform distribution of light over the entire slit width. This adjustment is usually required each time an exciter lamp is replaced and involves rotating it about its vertical axis.

Any one, or a combination of these adjustments, if improperly done, will produce frequency and amplitude distortion as well as reduce the output of the system.

There are, of course, other sources of degradation of audio quality, such as dirt collecting on lenses and mirrors and mechanical disturbances in the sound drum stabilizer. Cleanliness of equipment is of great importance and routine cleaning and inspection of the sound reproducer should be observed with regularity.

Test Films

Adjustments of the sound optical system are usually accomplished by the use of test films. These test films are readily available from several suppliers, one of which is the *Society of Motion Picture Engineers*. A catalog of these test films is available from the SMPE.[2]

Most television studios have 16 and 35-mm motion picture projectors. Test films are available in both 16 and 35-mm. sizes.

For the determination of uniformity of illumination across the slit, two types of test films are available for 35-mm sound reproducers. They are known as Type A 17-Position Track Test Film, and Type B Snake Track

Reproducers

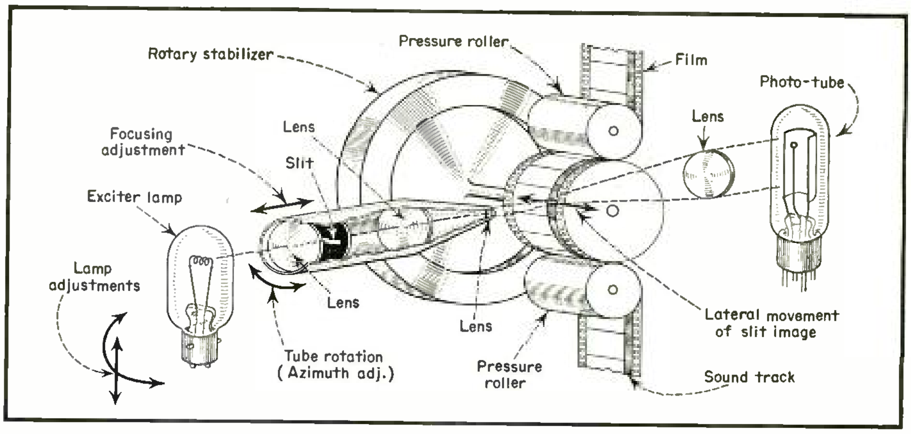


Fig. 1. Functional diagram of a motion picture reproducer sound-head. The essential components are shown. Arrows indicate adjustments necessary to produce optimum quality, and are explained in the text.

Test Film. The Type A is usually used by manufacturers in the production testing of equipment. It contains 17 very narrow tracks uniformly distributed across the sound track width. Each of the 17 tracks appears on the test film for a sufficient time to make a reading of the output of the sound with a volume indicator. With this type of film it is possible to plot a curve of light distribution across the slit width.

Type B is usually used for maintenance of such equipment in the field and is to be preferred for television sound reproducer maintenance. The Type B track is made of a very narrow sound track which, when put in motion in the sound head, moves across the slit at a uniform rate and a measurement of audio output is made. Uniformity of illumination across the slit is indicated by a minimum variation in sound output and can usually be held to within ± 1.5 db. A one-hundred-foot reel of Type B track is sufficient to enable the operator to make the necessary adjustments of the exciter lamp position.

For adjustment of the position of the slit image upon the sound track, a buzz track test film is available. The sound track of this film is completely opaque. However, a 300 cycle square wave track is located immediately to one side of the normal sound track location and a 1000-cycle, square-wave track on the other. The tracks are located so that when the film is run in a sound projector properly maintained, neither tone is heard. If the slit image is out of adjustment laterally, either the 300 cycle or 1000 cycle tone will be heard. Usually one hundred feet of the film will give the operator sufficient time to make this adjustment. Buzz track film is available in both 35-mm and 16-mm stock.

Sound Focusing Test Films, both 16 and 35 mm, are used to adjust the azimuth and focus of the optical system. The SMPE makes available several types. They consist of 5000 or 7000 cycle tones in either variable area or variable density. The variable density is more sensitive to small changes in azimuth and is to be preferred for this test. Correct azimuth and sharp focus are both manifest by maximum output as observed with a volume indicator. Some reproducers have the azimuth pre-adjusted at the factory and should not be tampered with. Usually from 100 to 200 feet of the film is all that is required.

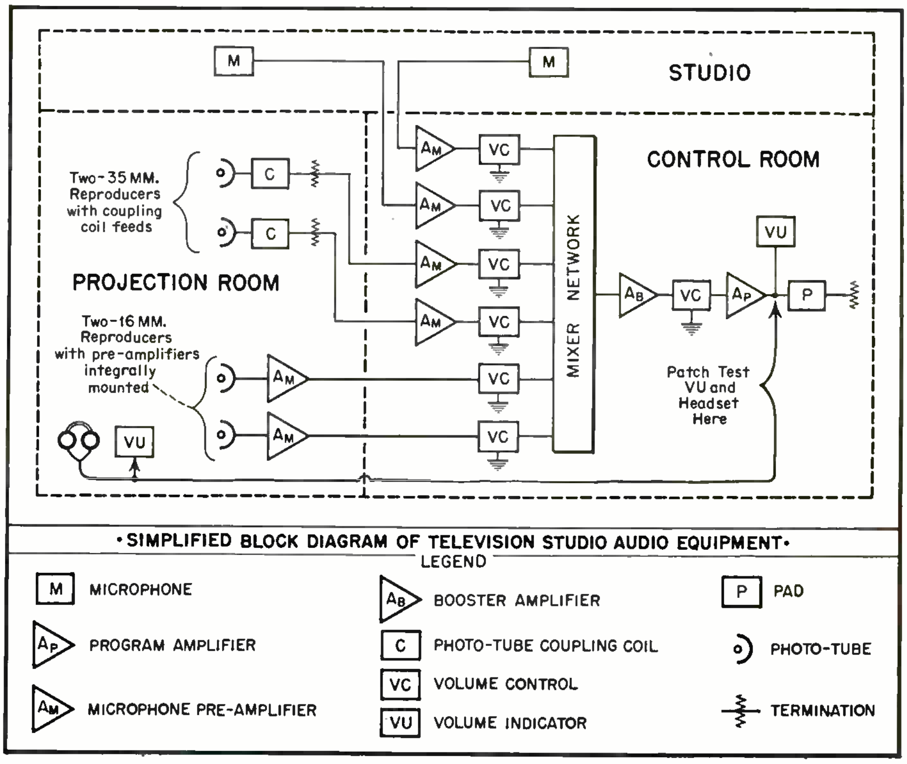
Multi-Frequency Test Film

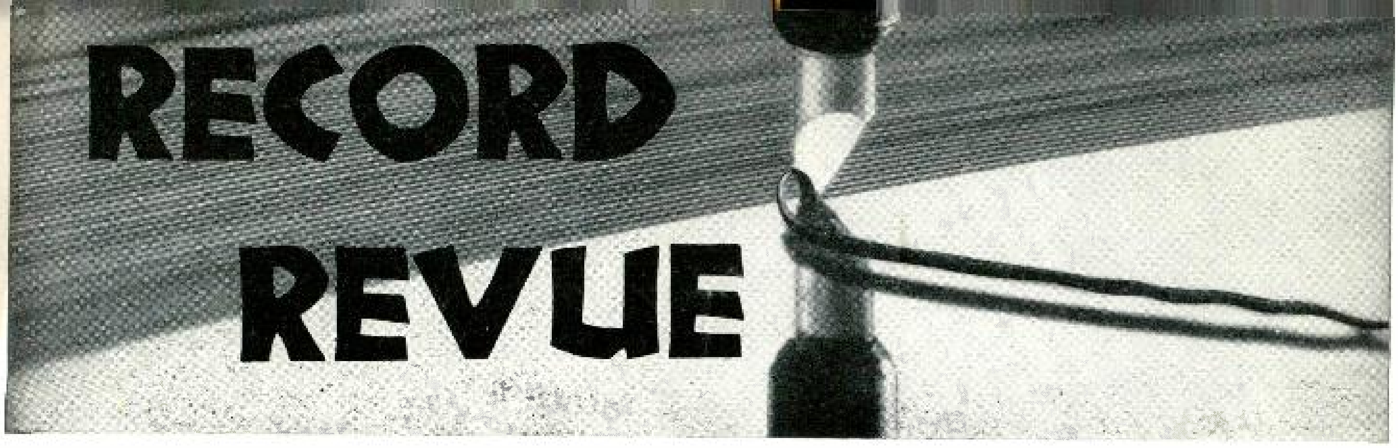
Multi-frequency Test Film Type B is normally used in routine servicing and includes frequencies from 40-8000 c.p.s., each preceded by a spoken announcement. Enclosed with each individual reel is a chart of the correction factors that must be added to the volume indicator deflections to obtain the correct frequency response of the system. 16-mm Multi-frequency Test Film covers a somewhat more limited frequency range but is handled in the same fashion as 35-mm.

Oftentimes the operating staff of a station plays prints which sound unpleasant. Question arises at once as to whether the equipment is defective or whether the recorded material is faulty. The Theater Sound Test Film, which is also available in 16 mm, is considered by the motion picture industry to be representative of currently available release prints of quality consistent with the state of the art. This film is used for listening tests by the industry and should show, by direct comparison, whether prints which the

[*Continued on page 36*]

Fig. 3. Most microphone preamplifier inputs do not constitute a proper load for phototube coupling coils, therefor external terminations must be provided as shown.





EDWARD TATNALL CANBY*

The business of this column seems to be often enough a matter of poking innocently into assorted aspects of engineering that every trained technician knows all about, on the general theory that sometimes the specialist doesn't see all of the forest due to the large number of annoying trees in the way . . . So with the well-known Fletcher-Munson curve, which every engineer must have absorbed at some point.

Item: For 20-odd years I've been annoyed, during radio concerts, both live and broadcast from phonograph records, at having to rush over to the radio periodically to turn down the announcer, then back, to turn the music back up again. Putting aside the matter of commercials, etc., and supposing I really wanted to listen to said announcer—the phenomenon remains. Why, everyone is asking, do they broadcast announcers at concerts so terribly loud, compared to the volume of the music? Why can't the announcer talk at such a level that we can have a good, solid musical sound and not have to run into a perfect bellow when the voice comes in?

A very interesting question, especially when you watch the VU meter on a control board—which indicates quite clearly that the announcer's peaks are generally *less* forceful than the music!

Now several things must be granted, as to psychological possibilities here. The announcer actually is talking, man to man, at a fairly low original volume. Such a voice as it comes over the air, is distorted, if the volume reaching the ear is any higher than the original studio volume, at mike; a distortion we are thoroughly accustomed to, but still a distortion. Whereas the music suffers from exactly the opposite distortion, at least in the loudest portions: it reaches the ear at a lower volume than at the mike. (Just try to turn up a superduper big outfit to approximate actual orchestral fortissimo dbs and *then* listen to the announcer without changing the volume!) We are well able to take these two distortions in volume *separately*—but when suddenly put together in close proximity, their opposite distortions are too much for the ear. Either the music is too soft or the announcer too loud—for obviously in the studio they were never anywhere near on equal terms.

But that is only one aspect. Fletcher and Munson come into the picture, too, so far as I can see. The above is a matter of association, of experience and habit. How about the actual loudness? Imagine my astonishment, the other day, when the engineer at the control board of a local station —it was on FM—only at the moment—suddenly asked us to watch the VU level he was going to use, as a classical symphonic record came to an end and the announcer came in. Down it went, all of 6 db, at the peaks. Wonderful! For once, to the ear, the loudness balance was right—no jumping to reduce the volume. This engineer opines that the ideal, as he hears it, might be as much as 8 db lower, or more. (Discounting practical requirements such as fringe-area listening on AM.) The same thing applies even more strongly to the matter of applause at symphonic and other classical concerts. With the meter reading zero, the loudness of applause is enormously greater to the ear than the average of the music and far more unpleasant, even than the loudest musical peaks. Match the loud final chord of a symphony to the succeeding applause by ear-tolerance and you'll have radically different readings.

It would be up to you sound men to demonstrate it statistically, but it seems quite obvious that a major cause of this loudness difference is the Fletcher-Munson relationship. Symphonic music, especially as played "high fidelity," covers a wide frequency band, with a great deal of important sound at the two ends. The entire tone color apparatus of the mind depends on sounds that approach the vanishing point on the hearing-vs.-db scale. On the other hand, the male human voice concentrates its power in the ear's most efficient range, the "middle" tones (which is only reasonable, since the Lord created both the ear and the voice as part of the same living mechanism!). A little voice-power goes a long way, ear-wise. Clapping, I would hazard a guess, is similarly powerful. Music is inefficient as sound, requires very considerably more umph behind it to give proper loudness. All of this, of course, in addition to the associative matters already mentioned, the "normal" levels of speaking voice and music. With combinations of voice and music increasingly common in all forms of recording, this little problem of relative levels is going to get pretty warm even outside of radio. Frankly—as a radio listener— I'd say it's a mess right now.

Item: While F-M curves are before the house, may I remind readers of the McProud-designed compensated volume control as a fine example of the sort of thing that can happen when an engineer really begins to take F and M seriously. Maybe it's not quite as simple as your cheap radio volume control and maybe it won't appear on every other sound outfit day after tomorrow. But the fact is, it works. If we make a fuss about wide range, about speaker placement and all the rest in the name of more *natural* sound, greater fidelity—then surely we can't ignore the very great difference between ear curves of response at high levels and at low. How many sound outfits owned by readers of this magazine take this factor into accounts? *Plug*: see Audio Engineering, May, Nov. 1948.

Item: Another rather curious application of Fletcher-Munson, not quite so simple, is Mr. H. H. Scott's in the dynamic suppressor. Let's not get into suppression again—'nuff said—but suffice it that Scott says we won't miss the cut-down highs and lows at low volume levels in the music because according to F and M we don't hear much of anything in those regions anyhow, given very low levels. Our hearing drops off faster at the ends than the middle, as volume decreases. This is certainly not to be denied. What I question is the assumption that low-level music, as the ear receives it in a good home or lab sound outfit, is at the same level as heard in the concert hall.

My ear says, no. (That is, from where *I* usually sit in the concert hall; and

[*Continued on page* 27]

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

Studio Control Room Design

ROBERT V. KINNEY*

Technical details of an efficient control-room layout.

FOLLOWING World War II, almost every broadcaster considered the advent of FM in the design of new studios and control rooms. In this connection, nearly all manufacturers of studio consoles designed them to incorporate two output channels, so that programs could be fed to both AM and FM transmitters. The design of these consoles was such that in most cases they fit the over-all requirements of an average control room. Without question, however, each installation is a case by itself and must be considered as such.

In the design of the control room and studios at WRRN, four studios were considered. The requirements were such that it had to be possible to feed the output of any of these four studios to either AM-FM-Recorder or audition. In considering economy, it was decided to situate two General Electric consoles, four turntables, two racks, a high fidelity AM-FM all-band receiver and recording tables in the control room. To effect an operation such as this, careful consideration must be given to the acoustics of the control room. This design had to permit operation of two or more loudspeakers at a level consistent with good operation.

As shown in *Figs.* 1 and 2, the consoles in the master control room are arranged facing each other. Each console is situated so that the control operator may easily see into studios A-B from console 1, and studios C-D from console 2. Two turntables are wired to each console. All microphones, speakers, turntables and other circuits affecting flexibility, are brought out to jacks on the two racks. It is therefore a simple procedure to cross-patch any microphone or microphones, and the speaker, to the opposite console. Mounted on the wall and directly in back of each turntable are cueing amplifiers in the speaker cabinets. There are circuits built into each console to cue-in transcriptions; however, their use necessitates momentarily disconnecting the monitor amplifier from its normal position. To avoid this, separate cueing amplifiers were installed. These amplifiers are placed across the output of the pre-amplifiers, located within the turntables, by the operation of a spring return switch.

**Chief Engineer, WRRN, Second National Bank Bldg., Warren, Ohio.*

Remote Line Inputs

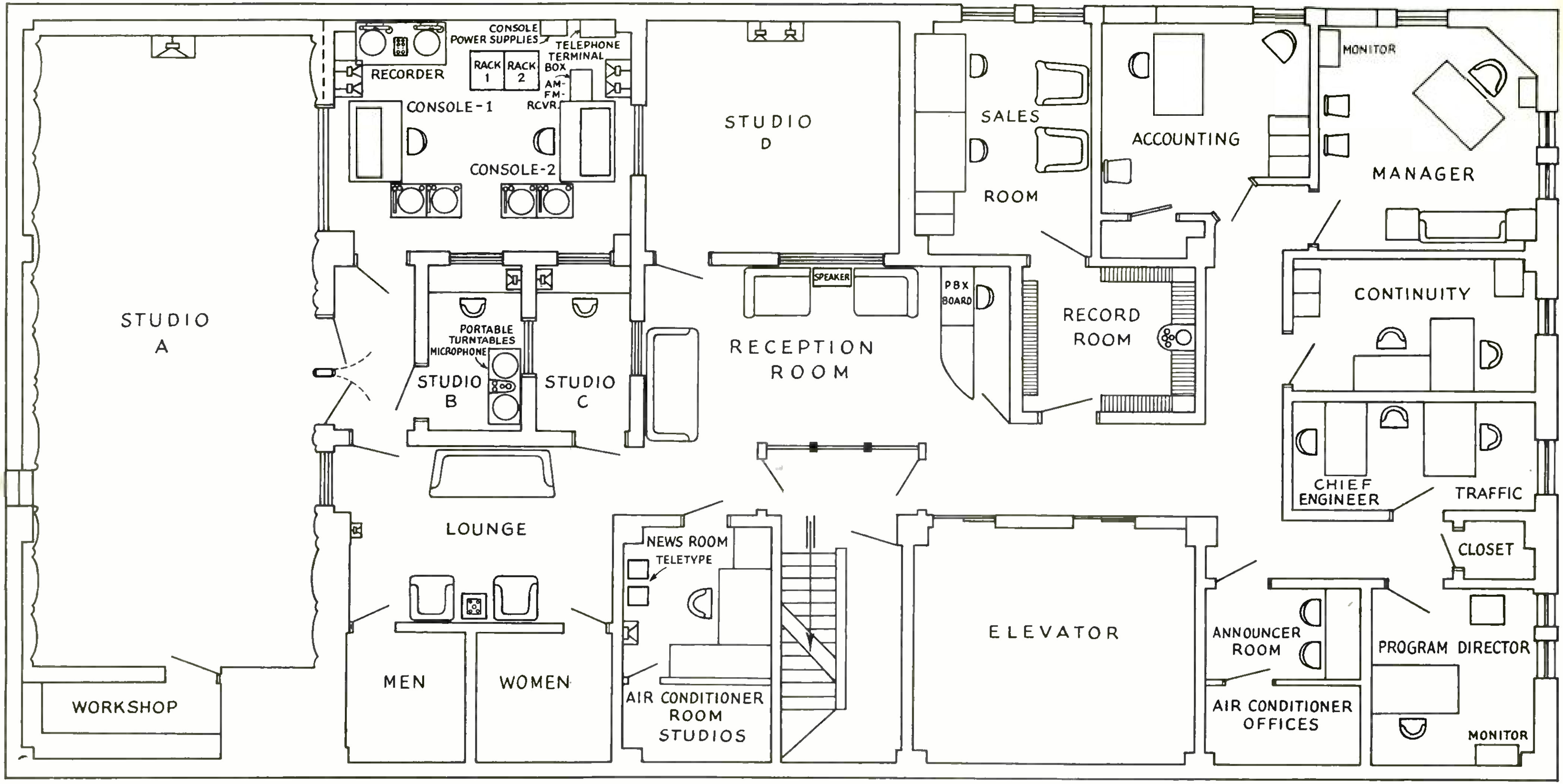
There are eight remote line inputs on each console. Associated with these remote inputs are also eight cue buttons. It is therefore possible to feed program or cue to any of the remote lines. A console with a remote input selector is quite convenient as it eliminates patching-up remotes provided there are a sufficient number of selectors when there are more remote pickups than remote inputs. Of course, there is a circuit allowing talk-back with remotes, as well as the conventional override circuit.

Remote line (1) on both consoles, is used for the incoming network circuit. It might be interesting to point out just how the network is brought into both consoles. It is desirable to have both consoles symmetrical, so a network program in progress may be moved from one console to the other without interrupting the program. Two isolation amplifiers were bridged across the output of the network line-equalizer. Any desired level up to 0 vu can therefore be obtained. One of these outputs is fed to each console, appearing as Remote One. It is then possible to feed a network program to the same line, either AM or FM simultaneously, and switch from one console to the other.

As mentioned, there is a high-fidelity AM-FM all-band communications receiver in the control room. This receiver is used to monitor AM or FM operation, as well as for many other applications. The output of the receiver appears on jacks at 500 ohms, and when adjusted to the correct level may be fed to any console as a remote.

It is interesting to note something new in broadcasting technique for this area. It is planned to broadcast a sports program over a key station over both their AM and FM transmitters

Fig. 1—The Master Control Room of WRRN, Warren, Ohio, showing the location of the control consoles, equipment racks, turntables and other facilities.



STUDIOS—WRRN

SCALE 1/8" = 1'

Fig. 2—Floor plan for WRRN, Warren, Ohio. This compact, efficient layout will be of interest to AM-FM broadcast station operators. A single Master Control Room services the four studios grouped around it.

Other stations located in other markets, but which are within the service area of the FM transmitter, will feed the output of a high-fidelity FM receiver into the console as a remote. The program may then be fed to their AM and FM transmitters. This operation should be extremely effective.

On each console, there are four monitor cue buttons. These are used to monitor the network, AM, FM and one which is a spare input which could be used to continuously monitor a remote line, output of a receiver, or any other circuit of suitable level. It is thus possible to allow any studio to monitor any facility at loud speaker level. For most purposes it is used as a monitor cue for either AM or FM when the following program is to be moved to an opposite console.

Talk-back facilities, so necessary in good operation, are built into the console. With every loud speaker in the studios, lounge, reception room, news and record library available through jacks, it is a simple procedure to cross-patch speakers to talk through any of these loud speakers. Cross-patching speakers is also possible to allow talk-back between any studios.

The four studios are so arranged that the control operators have unobstructed vision into two studios from each console. Studio *A*, *Fig.* 3, the largest of the four studios, is used for audience participation, seating about 100 people. Studios *B* and *C* are large enough to accommodate three announcers. Studio *D*, smaller than Studio *A*, is used for small groups. Four microphone outlets appear in each studio. In studios *A* and *D*, there are four utility outlets used for monitoring and additional microphone outlets if ever required. The utilities are also used to feed the output of a portable set of two turntables, one microphone and respective amplifiers, at 0 vu to the control room where it may be entered as a remote. This unit is invaluable for sound effects or for record programs where the announcer wishes to cue and operate the turntables.

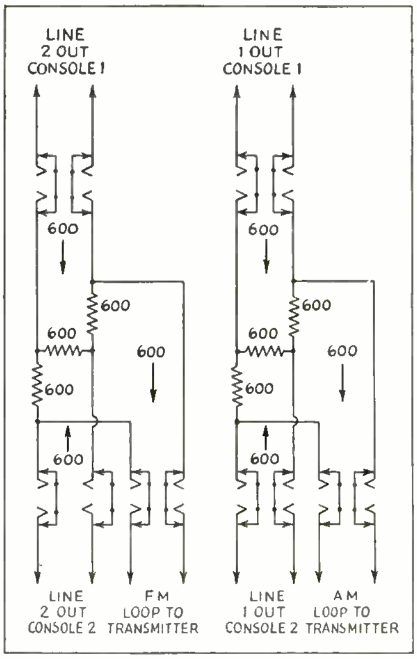


Fig. —This special output circuit arrangement is used to permit transmission to either the AM or the FM transmitter from either one of two program consoles. The circuit is actually a Wheatstone Bridge that provides a high degree of isolation between the two input circuits provided all legs are of exactly the same resistance value. The outgoing line, which constitutes the fourth leg, will not meet this requirement unless a large pad is used to isolate line impedance variations from the bridge. Isolation coils would be needed.

Isolation Amplifiers

Bridged across the AM-FM and network lines are three isolation amplifiers. The output of these amplifiers forms a cable of the three pairs which run to each of the studios and all of the business offices. These outputs appear on wall receptacles. A small amplifier is bridged across any one of the three lines by a selector switch allowing any office to monitor AM, FM, or the network. In the case of the studios, a selector switch picks up any one of the three lines and connects it to a headphone jack. It is then possible to monitor any one of the three lines.

Upon considering the outputs of the program amplifiers of the two consoles, it was decided at first to utilize relays. These relays would connect a selected program amplifier to the AM or FM loop. Such design, while adhering to sound principles, was not the answer. The use of relays would allow lock-outs, increase maintenance and cause a subsequent increase in the over-all cost of the installation. The answer to this problem was the use of impedance-matching resistor networks. One of each of the two program amplifier outputs was fed to either end of the pad, the output of the network being connected to the line as shown in *Fig.* 4. This arrangement eliminated all complications. The outputs of the program amplifiers can well stand the loss caused by the use of the pads.

When the control room installation was completed, distortion and frequency runs were made on the equipment. Padding down the output of an audio oscillator to simulate the output level of a microphone and attaching a noise and distortion meter to the output pad, measurements were made. The

[*Continued on page 35*]

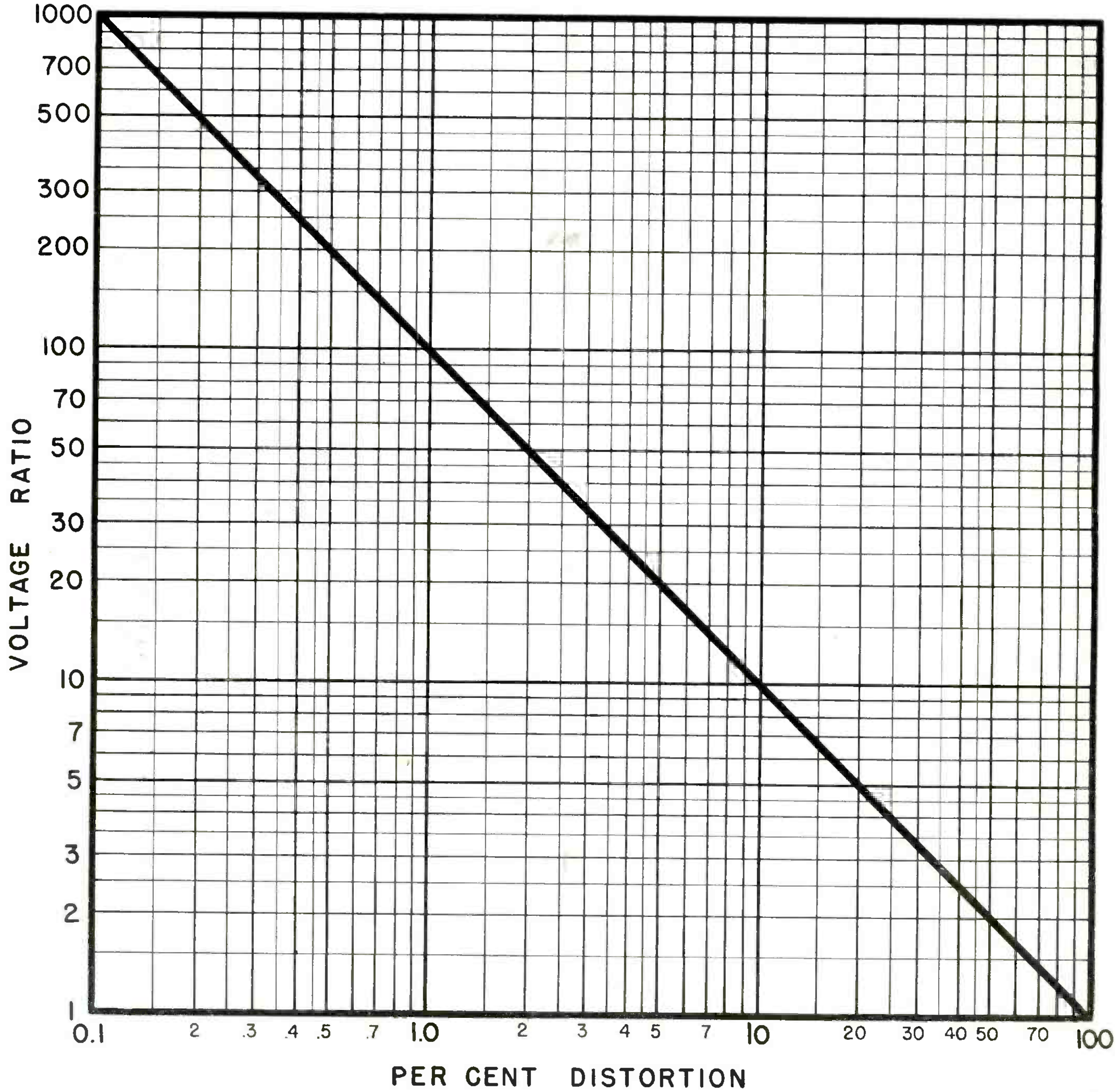
Fig. 3—This studio at WRRN is approximately 16 x 36 feet and can accommodate an audience of 100 people. Reference to Fig. 1 shows the relation of this studio to the associated control room and its convenient relation to the entrance lobby of the station.

AUDIO DESIGN NOTES

VOLTAGE RATIO VS. PERCENTAGE DISTORTION

BY

H. P. MEISINGER
Chief Engineer, U. S. Recording Company



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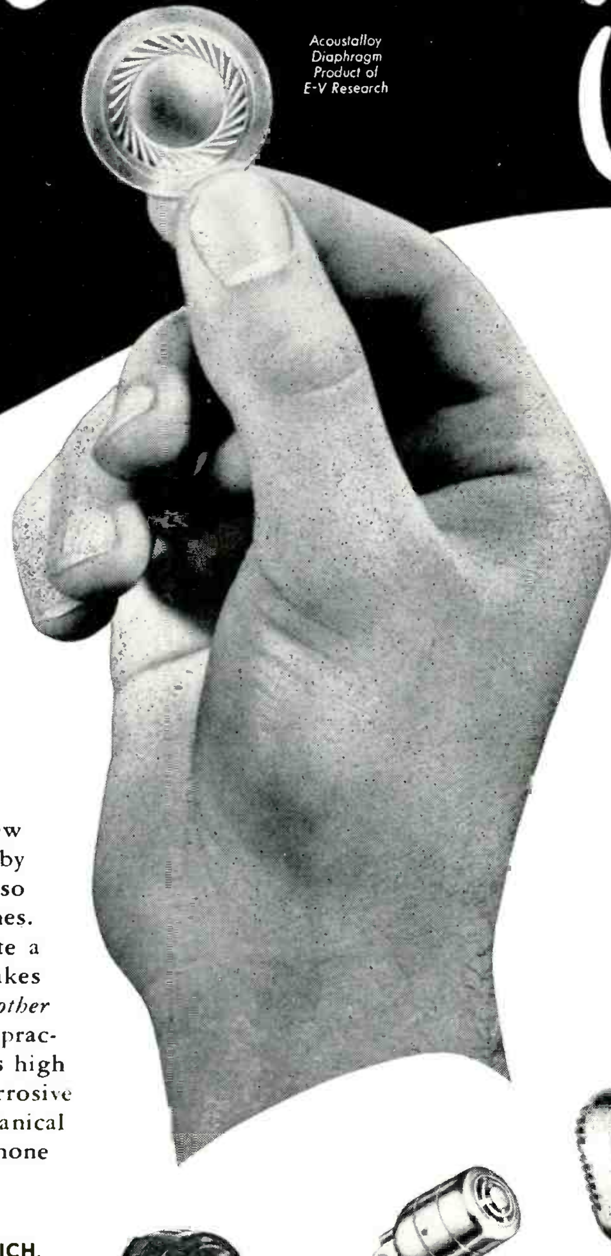

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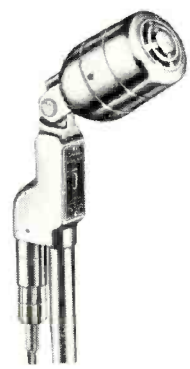

The "635"
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The "CARDYNE"
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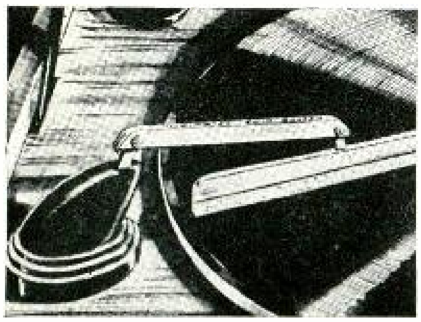
NEW PRODUCTS

CHIP-CHASER

● Audio Devices, Inc., 444 Madison Ave., New York 22, N. Y., has developed and is now marketing a unique and highly effective device for preventing a recording "chip," or thread, from getting tangled up under the recording stylus. This Chip-Chaser consists of a light-weight, aluminum-backed strip of felt, attached to and supported by a heavy cast-iron base. In operation, the device is simply placed beside the recording turntable, with the felt strip laid across the recording disc. The chip from the cutting stylus is automatically and infallibly guided in to the center of the disc, where it harmlessly winds around the center pin. The felt strip is pivoted so that it can be tilted up out of the way when not in use.

The Chip-Chaser is self-aligning, requires no installation expense, and is so designed that it cannot scratch or in any way damage the surface of the recording disc. The manufacturer states that this device is a great labor saving aid for use with all outside-in recordings made on equipment which does

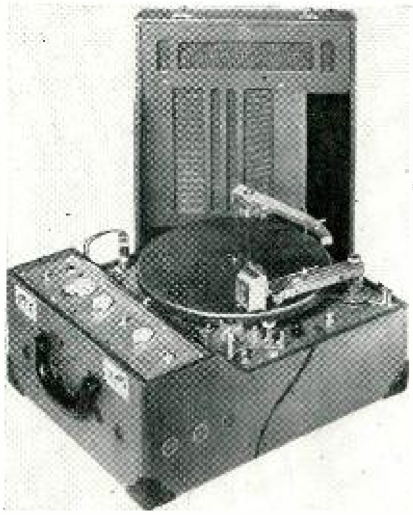


not include a pneumatic chip removal system. It relieves the operator of the responsibility of continually brushing the thread out of the way of the recording stylus, and prevents the possibility of spoiled recordings due to thread tangle.

The Chip Chaser is available in two sizes—one for use with all turntables up to 12" diameter, one for 16" turntables.

MICROGROOVE RECORDER

● The Presto Recording Corporation has recently announced two Microgroove Recorders and unusually high quality Microgroove phono record player. The two Microgroove Recorders are Types K-10 and Y-3,



which are modifications of the famous Presto K-8 and Y-2 types. The new units will do standard recording as well as Microgroove, and modifications include an advance ball on the cutting heads and dual purpose pickups. The quality of recording is excellent. The K-8 will record continuously for one-half hour on one side of a 13¼" disc. Microgroove units are offered at no price increase over former types.

Also announced by Presto is the 15 Series phono turntable, primarily for Microgroove but excellent for playing all types of records. They are built of finest materials and to close tolerances, assuring a minimum of wow, flutter and mechanical noise. This is of primary importance in playing Microgroove. The unit includes high quality pickup and walnut veneer cabinet, with one or two turntable speeds. It is also available without cabinet or pickup, if chassis only is desired.

MICROPHONE DESK STAND

● A new Model 426 Shockproof Microphone Desk stand is announced by Electro-Voice, Inc., manufacturers of microphones, phono pickups, stands and accessories.

The Model 426 combines modern streamlined "tear- drop" design with functional utility. Provides balanced, stable microphone support. Easy to use on desk or table for announcing, newscasting, station-breaks, emergency communications, amateur radio, etc.

Newly developed shock mount, with dual Lord shear-type mountings, is built into the base—provides double shock absorber action—prevents reproduction of external shocks and undesirable stand vibrations—reduce side-sway of microphone.

Finished in rich gray hammerloid. Bottom is fitted with waffle-type non-skid rubber shoe. Designed with adapter to fit all standard 5/8"-27 thread microphones and permit easy connect or disconnect of cable.

For further information, write to Electro-Voice, Inc., Buchanan, Michigan.

REMOVABLE STYLUS CARTRIDGE

● The Pickering Company of Oceanside, Long Island, N. Y., has developed a cartridge reproducer, their model R-150, designed expressly to give optimum reproduction of home phonograph records. The R-

150 features a replaceable stylus for economy. No longer is it necessary to return the cartridge to the factory for stylus replacement. With an R-150 a new stylus can be installed by hand in a matter of seconds and so provide excellent concert quality

record response at all times and at a minimum expense.

The R-150 is available with either a sapphire or diamond stylus, 2 to 3 mil radius. A sapphire stylus is good for several hundred playings while a diamond stylus is good for several thousand playings. Other features of the R-150 include: negligible accoustical radiation and needle talk; no appreciable response below 30 or above 10,000 cycles and no frequency discrimination between these limits; no extraneous sounds due to warped or imperfect records; of all commercial cartridges, the R-150 produces the lowest record wear; the stylus won't work loose but will actually tighten due to playing forces.

The Pickering R-150 Cartridge Pickup for amateur music enthusiasts will be available through leading dealers and radio jobbers.

RECORD REVUE

[*from page 20*]

I maintain stoutly that the best musical effect is in the balcony, or, if on the floor, well to the rear.) Mr. Scott's own portable sound measurer could clear the situation up for me, but meanwhile I state, for the reader's consideration, the definite impression I have that, speaking of the low-level end of the concert hall dynamic range, the average *pp* (pianissimo) passage is *very much lower* in level as it reaches me at my seat than the same music as I hear it at home under conditions of choice. (Not counting of course the times when music is background for steak and mashed potatoes or maybe an after-dinner nap.) My evidence is aural, circumstantial. Concert hall manners for instance. Have you ever tried merely to turn the pages of a slick-paper program in the middle of a *pp* passage? It's astonishing, but the tiniest crackle will rouse the neighbors for yards around. The most minimal whisper directly into an ear is decidedly disturbing. Even the faint rustle of clothes being arranged is unduly audible, and we all know what happens when the coughs begin. One splutter-and-spray fills the auditorium. Drop a program on the floor—you can't possibly pick it up until a loud passage drowns that tiny noise out. Yes, sound levels can be exceedingly low.

Admittedly, other factors operate, as compared with sound in the home, that might make my illustrations not quite an accurate guide to sound level. Silence in concert is a social mandate, whereas at home we are much more lax in our listening. Binaural sound in the concert hall gives such a sharp directional characteristic to small nearby sounds, and the general background noise level is so exceedingly low, that—paradoxically—these little noises, being easily separated from the music, are all the more annoying and distracting. They stand out, relatively, like ticks in quiet plastic. All the same, the fact that such sounds *can* be heard so clearly is plenty of demonstration that the music must be *extremely* low in level in these quiet portions. You'll find plenty of the *pp* passages in every concert. People save up their coughs for 'em. Has anyone ever actually measured an orchestra's level, really *pianissimo*, from a distant mid-audience position, the house full, and sound-absorbing, especially at ear level with acres of assorted clothing and headgear looming up between meter and stage?

Now at home, listening to the same music, we run into the monaural problem. Our tolerance for monaural background noise coming from the loudspeaker is tremendously less than under binaural conditions, even allowing for getting accustomed to it, as most of us have to do. And the noise is tremendously greater. Even the extreme action of the suppressor cannot approximate the utter quiet of a concert hall in a soft passage—and in such a case the suppressor will have already removed a gross proportion of the music itself. Furthermore, in all but a few records, mikes are on the average much closer to the music than the seat where I sit. At the lowest spots there is still considerable level reaching them. Compression or manual monitoring is likely to bring this up higher, sometimes a lot higher. So we rarely get a really ultra-soft passage on records—one where F and M might be counted upon. If level does begin to get down to concert hall *pp* approximation—we hastily turn it up higher, without worrying about the why and wherefore.

When you come down to it, whatever the reasons—and I may be on the wrong track—the very lowest recorded passage I can imagine when played at normal listening volumes in the home, is still plenty loud enough so that the highs are scarcely affected by the Fletcher Munson principle—the proof being that *you can hear them so when the suppressor is switched in.* (Just the same, it's a good gadget because it makes an optimum compromise, which is all it was ever meant to do.)

Anyone want to argue?

Recent Recordings

Prokofieff
"Classical" Symphony; Finale from the ballet, *Chout*.
Boston Symphony Orchestra, Koussevitsky.
RCA Victor DM 1241 (2)
Comparison:
Philadelphia Orchestra, Ormandy.
Columbia MX 287 (2)

An interesting all-around comparison. First: the painful choice between 3-side (too short) and 4-side (too long) versions.

First and last movements fit nicely each on a side. But—combine the second, slow, movement and the short Gavotte on a side, as Koussevitsky does, and you have a rat race (even though K. manages to sound dignified and serene while making haste.) But play the second movement, best music in the symphony, at a proper leisurely pace and it fills the side, as in Ormandy's Columbia version. That leaves the Gavotte out in the cold. It isn't good for more than a couple of minutes, even in elephant time. Even so, I personally prefer this arrangement, with about an inch of sound on side 3; it treats the music better. However, the *Chout* excerpt is an interesting brassy bit of unheard Prokofieff.

Recording technique is contrasted. The Columbia set is made with close-up accentuation (it seems); instruments are sharp, steely, crystal-clear. Boston Symphony, as always, plays in a golden, distant setting—an over-all sound. For this small-size music, with its delightful writing for solo instruments, the Columbia scores better—in fact is one of my favorite examples of good microphoning for a given type of music. Try the two second movements (side 2) for the most striking contrast.

Rimsky-Koraskoff
Scheherazade.
Philadelphia Orchestra, Ormandy.
Columbia MM 772 (5)
LP: ML 4089

Every few months Columbia comes forth with another one of those super-brilliant recordings—mostly due to the music itself—which the engineers gobble up as demonstration material for audio equipment. This is the newest. (Earlier superdupers: Khatchaturian, "Gayne" Suite No. 1: Saint-Saens, Symphony No. 3.) This one has everything, from the biggest bass drum in the industry to a fine solo triangle, *pianissimo* and a solo violin (last few measures) so high that you can make it "disappear" by switching out the highs. Wonderful! More than that, Scheherazade is on LP and you'll find that the LP version, though at first it may seem quieter, less brilliant, thanks to absence of surface noise, is actually better and clearer on the high-highs than the shellac. Note faint drum and triangle passages. A smallish bird tells me that maybe the LP version has been treated to a run through a reverbetron to add a bit of liveness over the shellac version. Strange how nobody wants to admit such nefarious practices—the public might think its sacred music had been tampered with! Incidentally, *both* Gayne suites are now on a single LP, ML 4030.

Mendelssohn
"Italian" Symphony
Boston Symphony Orchestra, Koussevitsky.
RCA Victor DM 1259 (3)

A fine illustration here of the difference that *the music* makes in recording results. This is the same, or surely very nearly the same recording as in the "Classical" symphony (above). Same general acoustical conditions (probably Symphony Hall in Boston). Yet where in the Prokofieff it is too thin and distant, here, in a larger work, more heavily decked out with instrumental solidity, with fewer delicate solos, more massive string choir effects, the results are absolutely tops. The above mentioned "golden" effect of the BSO recording is ideal for this shimmering, gay, brilliant music. This is one of those "recent" Victors that show plenty of range, no distortion at all in the loud passages. Good stuff.

Thomson-Stein
Three Saints in Four Acts.
Original all-negro cast 1934) ; double chorus, orchestra, conducted by composer.
RCA Victor DM 1244 (5)

Maybe you like opera, maybe you hate it; either way, this album will make you howl! The opera's text is a masterpiece of persuasive sounding double-talk, gibberish that's so real you'd *swear* it means something. It probably does. The literary world has taken this quite seriously for years and, to tell the truth, I find it gets me too; there's something as fabulous as a Disney cartoon about it. The music is highly non-dissonant, sounds faintly preachy (the subject is religious) and occasionally gets the blues' real low-down. Recording is excellent; diction—all-important—comes through at optimum intelligibility. Complete text of this condensation is on the front and back cover. In case you don't know, composer Virgil Thomson is music critic on the N.Y. Herald Tribune and a revolutionary one, who, once in awhile, uses slang; never writes stuffily. Gertrude Stein is the lady who made a rose is a rose famous; also pigeons in the grass alas (to be heard in this recording).

Brahms,
Piano Quartet #3 in C minor.
Alexander Schneider, Milton Katims, Frank Miller, M. Horzowski.
Mercury DM 9 (4)

An excellent sample of the progressive-minded recording that Bob Fine and John Hammond were doing for the then Keynote catalogue, now taken over by Mercury. Distinction of this job is again in single-mike, over-all technique, very live (but never confused), wide tonal range. The ffrr-like idea of little or no monitoring I'm not so enthusiastic about. Fine stuff if you have no surface sound, but it's not practicable, I say, for even the best shellac—if you plan to play it wide-range. Better to keep the level up a bit, and trust to the principle of *apparent* dynamic range resulting from tone color change, as discussed in this column, AUDIO ENGINEERING, July 1947. With wide range reproduction this factor gives an astonishing amount of apparent de-compression, in the hearing. . . . To finish with Brahms, the balance here is excellent, the piano particularly nice, the whole sounding not like "chamber" music, but big, ample, full, as of course it was intended to sound. The performance is tops. Surfaces not quite so tops.

Delibes
Coppélia—ballet music.
Constant Lambert, Royal Opera Orch.
Columbia MM 775 (4)

Lecocq
Mlle. Angot Suite.
Efrem Kurtz, New York Philharmonic.
Columbia MX 305 (2)
LP: ML 4083

(LP version of Mlle. Angot includes Kabalevsky, The Comedians.) If you like light-weight, tuneful ballet music for plenty of orchestra, these'll do very nicely. Good comparison of Columbia-England and the same, U.S. variety. The Mlle. Angot is another in the fabulous series under Kurtz that began with the Gayne suite. The music isn't technically as stunning for recording purposes as the noisy Khatchaturian number but it still comes off brilliantly, if somewhat on the coarse side. The British recording is wide range too, with fine liveness—strange how, nevertheless, this and similar British offerings don't come up to the ffrr standard. It can't be altogether the tonal range; it must be the acoustics and microphoning—or is it? Compare with the Decca ffrr Sylvia ballet music, if you want to try judging for yourself. Not much doubt about the difference—but *what is it?*

Incidentally, I suspect the British Columbias now being imported have not only the European low turnover but also somewhat less high pre-emphasis than most domestics. Boost the highs in the Coppelia above and they come out nicely; but with too much surface, of course. It would be good if Columbia could dub these from the originals, substituting their own standard curve. (But maybe English Columbia wouldn't tell 'em what the original curve was. State secret.)

Erna Sack
album, vol. 2.
Erna Sack, various Orchs.
Mercury DM 30 (3 10")

Why is it we gape when somebody sings a high note that's recordbreaking? It's not beautiful, not music—only a physical impossibility become real. Sack's lower, normal tones are just nice, easy Viennese-style singing. But suddenly she hops up a couple of octaves into the supersonic range, for no particular reason. Incredible. Some of her stuff is rather nice, innocuous, friendly music; some of it is pure corn, a la hotel orchestra. But engineers note: this album shows remarkable tonal range, excellent recording. Probably done since the war; evidently represents what's new in Germany and Czechoslovakia. Not bad.

Berlioz
Requiem.
Emile Passani Choir and Orchestras, Fournet.
Columbia MM 769 (11)

Few engineers will shell out for this colossal album, I suppose, but it merits their attention, for several reasons. Put aside the fact that this is a noble piece of music, for a perfectly huge aggregation of performers numbering many hundreds; ignore the fact that the microphone pickup of all this, in a big French cathedral, is quite extraordinary, considering. Take only the one fact, that this is a fully wide range recording, excellent highs, very low distortion, and that according to one source it was recorded in Paris *five years ago.* That makes it 1943. Just who was making wide-range recordings in France at that point—and on whose equipment! Most certainly not British. The company was Pathé-Marconi, they say. The darndest things went on in Paris during the Occupation. . . .

Scarlatti
Six Sonatas.
Vladimir Horowitz, piano.
RCA Victor MO 1262 (2)

[*Continued on page* 32]

If you tried the recent Pictures at an Exhibition album by Horowitz, you'll find this one as good piano recording, as remarkable playing—though the music couldn't be more different. These are harpsichord pieces, for double keyboard, with the wide range of tone colors the harpsichord can give with its registration (like an organ). Most pianists just make them sound silly and precious; Horowitz makes them big, massive, as well as brilliant, as they sound in the original. (The sonatas are one-movement, varying from three or four minutes down to thirty seconds or so. Remarkably concentrated music, with plenty to it.)

QUALITY REPRODUCTION

[from page 11]

results, with all data in per cent:

Classical Music

Band	*Average Listener*	*Musician*	*Gannett & Kerney*
60-8,000	40	46	9
120-5,000	60	54	91

Male Speech

Band	*Average Listener*	*Musician*	*Gannett & Kerney*
60-8,000	64	76	80
120-5,000	36	24	20

Note that in the classical music group the choices are much more evenly balanced than Gannett & Kerney's discernability data. In the male speech group we have the first foretaste of special significance: the musicians are choosing the wider band almost as certainly as the probability of detectability would permit.

Applying the same method to the 8,000 and 10,000 cycle pair, we get a very interesting result:

Classical Music

Band	*Average Listener*	*Musician*	*Gannett & Kerney*
20-10,000	22	12	30
60- 8,000	78	88	70

Male Speech

Band	*Average Listener*	*Musician*	*Gannett & Kerney*
20-10,000	33	38	38
60- 8,000	67	62	62

In the music group it should be noted that the two bands are separated by less than one difference limen (one limen is defined as a 75:25 choice), but both average listener and musician show a vote separation of greater than one limen. They are detecting a difference more certainly than the experts were able to do (with good program material). We are forced to conclude that the music spectrum between 8,000 and 10,000 cycles was tagged by distortion products which marked it so strongly that average listeners were able to detect it with great certainty.

In the male speech group we see the same effect, to a lesser degree, in the average listener results.

This is a confirmation of our statement that the public will reject greater bandwidth with vigor if the added range is flavored with distortion products.

Objectives

Quality improvement can have only two commercial objectives: to increase the sale and use of radio sets, amplifiers, and components. It is obvious that there is a point of diminishing returns, and that going beyond it will be exceedingly unprofitable.

It is clear that a set with greater band width than the customer wants can still be used by turning down the tone control, whereas a set with inadequate band width built in cannot be so provided with band spread. On this basis we can estimate from the Chinn and Eisenberg data what would be the relation between upper cutoff frequency and the proportion of satisfied listeners.

Upper Cutoff Frequency	% of Satisfied Listeners
5 kc	50
8 kc	90
10 kc	99
12 kc	99.9

This assumes a system which is relatively free from fatigue producing factors.

We conclude from this table that

about one-half the radio sets and phonographs made should have satisfactory audio response up to 8 or 10 kc. If they are to use this bandwidth satisfactorily, a number of changes in component, broadcasting and phonograph record practice will be necessary.

Broadcast network lines will have to be improved. It is absurd to have studio input systems whose response is uniform to 15 kc, and transmitters whose response is in the same class, coupled by long lines which cut off sharply at 5 kc. Available are 8 kc lines, at an average increase of only about $300 per month per station. In many parts of the country today, the night time listener has available only 5-kc network programs.

The broadcaster who uses discs extensively will have to pay a little attention to the quality of his reproducers and records. Damaged reproducers or worn reproducer styli can cause intermodulation distortion of the order of 30%. Badly worn records, and records cut many years ago with extremely poor quality, are still in use. One has only to listen to discover that record reproduction is on a very low quality level in too many stations.

A few network broadcasters have taken the extraordinary step of using cheap, home-type wire recorders for their delayed broadcasting. We can see no possible excuse for such a degradation of quality.

Phonograph recording quality for 10 years has been adequate to meet the challenge, but many phonograph records cannot. We must make the production pressing nearer to the test pressing in quality.

Some manufacturers of inexpensive loudspeakers must mend their ways. Little has been done and nothing has been published on loudspeaker art can be traced directly to the secrecy tradition and lack of exchange of information by those in loudspeaker engineering. It is noteworthy that the BBC has published several times as much information on loudspeaker engineering as that released by all the loudspeaker manufacturers in America. The tricks of the trade will have to be regarded for what they are; "tricks" in the worst sense.

Finally, the set manufacturer will have to pay more attention to the audio part of his design. The present practice of having one of the technicians casually throw an audio system onto the tail end of an elaborately designed r-f circuit will have to stop. This policy seems to be at its worst in popular priced television sets.

Conclusion

This paper can best be summarized by saying that the typical set engineer is very wrong in thinking that the auditory system is easy to deceive, and that perpetrating an acoustic fraud upon it will have no repercussions. Whereas the eye rebels very fast at unsatisfactory conditions, the ear is slow to anger. Even when very angry, it does not directly reveal the cause of its rage. Yet, in the end, it enforces its desires surprisingly well. Every time a listener yawns and turns off his set, his ears have won a victory.

Reference

[1] H. E. Roys, Intermodulation Distortion Analysis as Applied to Disc Recording and Reproducing; *Proc. I.R.E.*, vol. 35, no. 10, pp 1149-1152, Oct., 1947.

[2] D. E. L. Shorter, Loudspeaker Transient Response; *BBC Quarterly*, vol. 1 no. 3, pp 121-129, Oct. 1946.

[3] Harry F. Olson, Frequency Range Preference for Speech and Music, Talk before *Acoustical Society of America*, May 9, 1947.

[4] H. A. Chinn and Philip Eisenberg, Tonal Range and Sound Intensity Preferences of Broadcast Listeners; *Proc. I.R.E.*, vol. 33, no. 9, pp 571-581, Sept. 1945.

[5] D. K. Gannett and Iden Kerney, The Discernability of Changes in Program Band Width; *BSTJ*, vol. 23, no. 1, pp 1-10, Jan. 1944.

[6] Harvey Fletcher and W. A. Munson, Loudness; Its Definition, Measurement and Calculation; *Journal Acoustical Society of America*, vol. 5, no. 2, p 91, Oct. 1933.

— *Letters* —

[*from page 6*]

inverters and the application (and effect of, etc.) of negative feedback.

In this country we were using amplifiers after the style of your 6AS7 one before the last war. The amplifier on page 19 Sept. '48 issue was originally designed here in England and is a good example of our standards. Very few designers now use tetrodes in HiFi amps; triodes are almost invariably used. Most amps have an output of 10-15 watts, less than 0.1% harmonic distortion and are flat within 0.1 db over at least 20-20,000 cs. A damping factor of at least 10 is considered essential, some (the one mentioned above for instance) have an output resistance as low as 0.5 ohm on 15 ohm winding, a damping factor of 30! Most HiFi systems have a "main" amp loading with about 1-5 volts input which is preceded by suitable "pre" amps. The "main" amp is left "wide open" as far as frequency response goes, recording correction is done in the "pre" amp. Some people always want to "help" the composer but the majority leave the response alone, once set. The tone control controversy also rages in this country and we have many queer ways of making the response as nonlinear as possible.

Corner horns and acoustical labyrinths are now in common use, also bass reflex and a few infinite baffle types, also we have many excellent speaker units for those who wish to build their own housings.

In pickups we have light weight HiFi crystal, magnetics, needle armature, dynamics and a few of the ribbon type. The magnetic is about the most common and a fine example of this type is the Decca ffrr PU with a flat response from 30 to 14,000 cs.

But with even the very best of this fine apparatus, many (including myself) are dissatisfied with the results and are always seeking better reproduction. The never-ending "Quest for Quality."

Once more I thank you for your fine efforts in the field of fidelity and sound in general, keep it up please.

H. G. Warren,
88 Wellington St., Luton,
Beds, England.

CONTROL ROOM DESIGN

[from page 23]

highest distortion occurred at 400 cycles and was measured at .82%. This measurement was made with an output level of +16 db. The lowest distortion measured .6% at 30 cycles with an output of +16 db. A frequency run indicated each channel flat to ±1 db, 30-15,000 cycles. Measurements were made using a Hewlett-Packard audio oscillator, and noise and distortion meter.

In summing up the capabilities of this control room, the following operations are possible:

1. Feeding four different programs to different lines and recording one of the programs.
2. Feeding the network with one console and recording it. Receiving network program through the second console feeding both transmitters with a minimum of operating personnel and with one spare channel.
3. Feeding the network with one console and receiving this network program back through the second channel of the same console, recording and feeding it to either the AM or FM transmitter. This can be accomplished with no difficulty by one control operator. In this operation the second console would not be used.
4. Duplicating programming to both AM and FM transmitters and splitting up the station break so that "FM" after the call letters would be fed to the FM transmitter only. This can be accomplished utilizing one announcer and one control operator.
5. Complete flexibility whereby any of the four studios can be operated into any of the two consoles with a minimum of effort on the part of the control operator.
6. Duplicate systems in which the operation of any one of the two systems is not dependent upon the other thereby eliminating extended off-the-air periods.

One of the important items in considering facilities for a studio control room is total initial cost as well as operating cost. The total initial cost of the installation described averaged 60% of the quotation for custom-built equipment. Operating costs require serious consideration as they are continual. Here again it is at a minimum without any sacrifice in operational requirements. This installation has been operating for the past ten months. Other than tube replacements, and these have occurred within the maintenance schedule, no electrical or operational difficulties have occurred.

After this extended, continual experience with the facilities described herein, we feel that this is an answer to the constantly increasing demand for an efficient, low-cost, flexible studio control room design where the demand is to feed one or more programs to one or more channels. The compactness of the design makes it obvious in a quick glance that operating costs, both in the technical and announcing departments, are cut to a minimum. Aside from the purely technical standpoint, this design is very attractive, giving the impression of spaciousness without waste space.

FILM SOUND REPRODUCERS

[*from page* 19]

staff is called upon to reproduce are satisfactory.

Suggested Maintenance Technique

Figure 3 shows a simplified block schematic diagram of the audio portion of a television studio. In most cases the projection equipment will be set up in a separate room away from the audio control console. It will be necessary to use a portable volume indicator and high impedance headset at the projector while adjustments to that projector are in progress. A bridge of the audio line amplifier output as indicated on the diagram may be run from the control console to the projection room to feed this volume indicator.

Experience has shown that there is a preferred order in which the test films are to be used and adjustments made. It is recommended that adjustments be made in the following order:

1. Azimuth (use Sound Focusing Test Film)
2. Lateral adjustment of slit (use Buzz Track Test Film)
3. Uniformity of slit illumination (use Snake Track Test Film)
4. Focusing Adjustment (use Sound Focusing Test Film)
5. Frequency response (use Multifrequency Test Film)
6. Listening test (use Theatre Sound Test Film).

The location and method of adjustment for each different type of projector is usually found in the manufacturer's instruction booklet.

Noise and Distortion Measurements

Until now we have not mentioned making quantitative measurements of single frequency distortion, or noise level. None of the projector manufacturers will state that with such and such a test film, his projector will produce so much percent distortion. Such conditions are rarely encountered in practice and have little meaning[3]. There are no accepted standard methods of making such measurements, nor are there any quantitative tolerances. Suffice it to say that recognized 35-mm movie producers follow as closely as possible certain recommended practices made by the Motion Picture Research Council and the Society of Motion Picture Engineers with regard to the recording of sound film. Even so, some variation in characteristics exists in film products.

Because of the many variables involved, it is difficult to make any general statement about film distortion. However, 35-mm film distortion runs in the order of one to two per cent root-sum-square between 400 and 1000 cycles and is in the neighborhood of four per cent root-sum-square at 3000 cycles[4].

If high distortion or intolerable noise is encountered, it may be well to suspect the audio equipment following the photo-tube. Measurements on the equipment following the photo-tube may be made employing the currently standard procedures and tolerances.

Incidentally, the motion picture industry has recognized the necessity of using low-pass filters for reproducing their film products in theatres. Such filters reduce noise and distortion on worn or scratched prints by "rolling-off" the higher frequencies according to certain specifications[4].

Flutter

Broadcast engineers are familiar with "wow" or "flutter", those spurious modulations attending the playing of poorly-made disc recordings or the use of defective turntables. In the motion picture industry, flutter is generally caused by irregularities in film speed due to dirty or worn projector parts involved in passing the film past the scanning point in the sound-head. Measurement of flutter usually requires the use of a rather expensive flutter bridge in conjunction with a flutter test film. The discovery of excessive amounts of flutter generally indicates defective mechanical parts which must be replaced by overhaul. It is recommended that theatre sound test film, which contains musical passages suitable for detecting flutter, be used in a preliminary listening test. If excessive flutter is suspected, quantitative measurements may be undertaken by outside service organizations equipped to do so.

As in allied electrical sciences, it is reasonable to expect that minimum performance standards and accepted measurement techniques eventually will be forthcoming in the motion picture field. Until then, however, the logical course for the television station staffs is to maintain their sound-film projectors obtainable through repeated checks, using procedures similar to those outlined.

REFERENCES

1. RMA Standard #TR-105-A Sept. 15, 1947
2. 16-mm & 35-mm Test Films (a publ.) by Motion Picture Research Council and Society of Motion Picture Engineers. 342 Madison Avenue, New York City
3. F. Durstt and E. J. Shortt: "Characteristics of Film Reproducer Systems," J. SMPE (Feb., 1939) p. 169
4. Research Council Basic Sound Committee: "Discussion of Magnetic Recording." J. SMPE (Jan., 1947) pp. 52-53
5. Standard Electrical Characteristics for Theatre Sound Systems, (a technical publ.) by Motion Picture Research Council. April 20, 1948

Magnetic Recording Head

[from page 13]

ination was acting individually so that there were as many tracks as there were laminations. Offset laminations also show up in a striking manner. Some notion of the fringing effect at the edge of the gap may be obtained by looking at long wavelengths. There is shown in Fig. 3 a 92 mil wavelength track where fringing is in evidence. It should be noted that in order to obtain clear tracks, a fairly strong signal must be recorded on the tape.

In conclusion, the authors wish to express their thanks to the management of Minnesota Mining & Manufacturing Company for permission to publish this material.

Appendix—Theory of Alignment

Schott's attack on the effect of non-parallel gaps in magnetic recording is essentially as follows:

For simplicity, assume a line gap and further suppose the flux intercepted by the reproducing head to be the sum of the induction in the tape under each increment of the gap length.

Let a tape whose length lies in the y direction be recorded with an induction B varying sinusoidally such that

$$dB = C \sin \frac{2\pi y}{\lambda}\, dX; \quad \text{for } \frac{-d}{2} \leq x \leq +\frac{d}{2}$$

which expresses the fact that the induction is uniform from —d/2 to +

d/2 in the X direction. Let the reproducing gap make an angle α with the X-axis. Any element dX of the gap will, therefore contribute to the flux pickup in the head an amount

$$dB_\alpha = C \sin \frac{2\pi}{\lambda}(y - X \tan\alpha)\, dX$$

where

$$\frac{2\pi X \tan\alpha}{\lambda}$$

represents the phase angle of the flux at X resulting from misalignment.

The total flux pickup is then given by

$$B_\alpha = C \int_{-d/2}^{+d/2} \sin \frac{2\pi}{\lambda}(y - X \tan\alpha)\, dX$$

or

$$B_\alpha = Cd \; \frac{\sin\beta}{\beta} \; \sin\frac{2\pi Y}{\lambda}$$

where

$$\beta = \pi d \tan\alpha / \lambda \qquad (1)$$

Substituting $y = Vt$, where V is the constant tape velocity and t is time, we may calculate the voltage developed in n turns of the pickup winding.

$$E_\alpha = -n \frac{dB_\alpha}{dt} = c'd \cdot \frac{2\pi V}{\lambda} \frac{\sin\beta}{\beta} \cos\frac{2\pi Vt}{\lambda}$$

The peak value of E_α occurs when

$$\cos\frac{2\pi Vt}{\lambda} = 1$$

or

$$E_{\alpha_{max}} = c'd \; \frac{2\pi V}{\lambda} \; \frac{\sin\beta}{\beta}$$

For a perfectly aligned gap

$$\alpha = 0,\ \beta = 0 \quad \text{and} \quad E_{0_{max}} = c'd \; \frac{2\pi V}{\lambda}$$

or the fractional decrease in voltage may be written as:

$$E_{\alpha_{max}} / E_{0_{max}} = \frac{\sin\beta}{\beta} \qquad (2)$$

For small values of α

$$\alpha: \quad \beta \cong \pi\alpha\, d/\lambda \qquad (3)$$

CORNER SPEAKER DESIGN

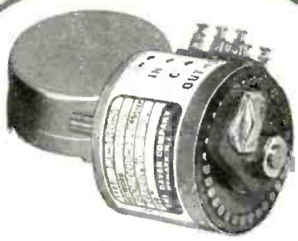
[from page 17]

it must, and plans are being drawn for a smaller cabinet of similar design, intended for use solely as a speaker. This model will use a good-quality 12-in. speaker for the woofer, and the Atlas HF-1 horn unit for the tweeter, the latter being mounted where the tube enclosure is in the original model. Thus it will be somewhat lower in overall height, and considerably less costly to build. Exceptional performance is expected from it, however, if the results obtained with the original model are any criterion. Next month's article will give the full set of performance characteristics together with efficiency measurements compared to a conventional 7.5-cu. ft. reflexed cabinet.

ADVERTISING INDEX

DAVEN

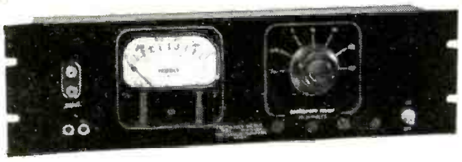
ENGINEERING LEADERSHIP



MINIATURE ATTENUATOR — TYPE LA-130
30 STEPS — DIAMETER 1 3/4 INCHES

30 step ladder network, provided in a minimum of space . . . recommended for use in high quality equipment requiring a wide range of attenuation, where mounting space is limited.

Here are 4 of the more recent DAVEN "firsts". DAVEN long has been known for leadership . . . particularly in engineering and design. Many of our developments have been incorporated in the equipment of broadcasting stations, sound recording studios, and electrical laboratories throughout the world, and are specified as standard.



FREQUENCY METER TYPE 838

. . . frequencies read directly to 100,000 cycles with an accuracy of ± 2% of full scale in use . . . 7 ranges available . . . low input voltage requirements . . . large, easy-to-read illuminated meter . . . mounted on a 5¼" relay rack panel.

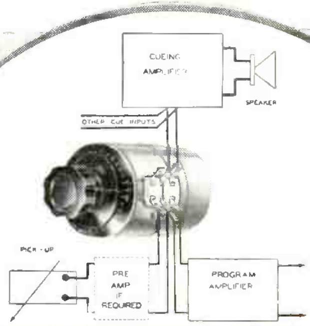
The DAVEN Engineering Department will be glad to discuss these new developments with you. Your inquiry is invited on the units shown or on any other DAVEN product.

THE DAVEN CO.

191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

TRANSMISSION MEASURING SET — TYPE 10A

Direct reading instrument . . . meters and associated range controls can be used independently as VU meters . . . range + 26 to −100 DBM . . . total attenuation 111 DB in steps of 0.1 DB. (Pat. Pend.)

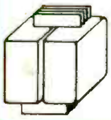


ATTENUATORS WITH BUILT-IN CUEING CONTROLS

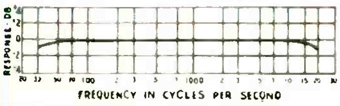
. . . eliminate the need for auxiliary switching mechanisms . . . also available with built-in switchette for a pilot light . . . may be obtained on Ladder, "T", Potentiometer, and Ladder Fader controls. (Pat. Pend.)

ENGINEERING UTC DEVELOPMENT

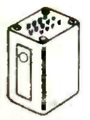
Since its inception, the designs of the UTC Engineering Department have set the standard for the transformer field.



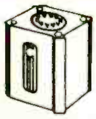
1933 — **Hum Balanced Coil Structure:** Used by UTC in practically all high fidelity designs. . . . Hum balanced transformers are now accepted as standard practice in the transformer field.



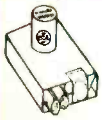
1934 — **Linear Standard Audio Units:** Flat from 20 to 20,000 cycles. . .A goal no others have met.



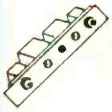
1935 — **Ultra-Compact Audio Units:** A complete series of light weight audio and power components for aircraft and portable applications. Ultra-Compact Audio units are hum balanced . . . weigh approximately six ounces . . . high fidelity response.



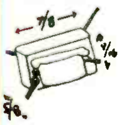
1936 — **Tri-Alloy Shielding:** The combination of Linear Standard frequency response and internal tri-alloy magnetic shielding is a difficult one to approach. Used by G.E., RCA, Western Electric, Westinghouse, Raytheon, Collins, Gates, etc.



1937 — **Ouncer Audio Units:** Extremely compact audio units for portable application were a problem until the development of the UTC Ouncer series. Fifteen types for practically all applications . . . range 40 to 15,000 cycles.



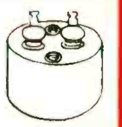
1938 — **Universal Equalizers:** The UTC Universal Equalizers, Attenuators, and Sound Effects Filters fill a specific need of the broadcast and recording field. Almost any type of audio equipment can be equalized to high fidelity standards.



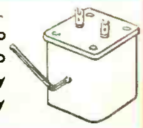
1940 — **Sub-Ouncer Units:** A series of ⅓ ounce miniature units with non-corrosive—long life construction for hearing aid, miniature radio, and similar applications. Five types cover practically all miniature requirements.

1941 — **Hermetic Seal Pioneering:** Realizing the essentiality of hermetic sealing for many applications, UTC pioneered a large number of the terminals and structures for hermetic transformers . . . now available for commercial use.

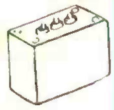
1942 — **Toroidal Wound High Q Coils:** UTC type HQ permalloy dust coils afford a maximum in Q, stability and dependability with a minimum of hum pickup. Standardized types for all requirements from 200 cycles to 500 KC.



1943 — **Variable Inductors:** The type VIC high Q variable inductor revolutionizes the approach to tuned audio circuits. Variation of +90% to −50% of mean inductance permits tuning any type of filter or equalizer to precise frequency characteristic.

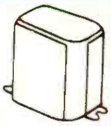


1944 — **Standardized Filters:** UTC type HPI, LPI, and BPI (low pass, high pass, and band pass) Filters are standardized to effect minimum cost and good delivery time. Available for frequencies throughout the entire audio range.

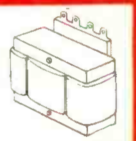


1945 — **Sub-Audio and Supersonic Transformers:** Embody new design and constructional principles, for special frequency ranges. ½ to 60 cycles for geophysical, brain wave applications . . . 8 to 50,000 cycles for laboratory service, 200 to 200,000 cycles for supersonic applications.

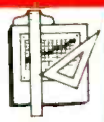
1947 — **Stabilized Low Frequency High Q Coils:** Temperature stabilized units for frequencies from 1 to 300 cycles with minimal variation in L for wide range in exciting voltage.



1948 — **Transductors for Power Control and Amplification Purposes Employing Nickel Steels:** These saturable reactors are available for frequencies from 25 cycles to 250 KC



1949 — **New Items:** The UTC Research Laboratory is developing new items and improving standard designs in 1949. While some of these developments will be described in our advertisements, many are applied to customers' problems.
Write for new catalogue



United Transformer Co.

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