AUDIO ENGINEERING

AUGUST
1949
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Including The Journal of the
AUDIO engineering society

RADIO-TELEFAX UNITS WITH SYLVANIA TUBES

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Pilot boat Captain sending written message of arrival of the big ship through Link unit equipped with Sylvania tubes, and in short order . . .

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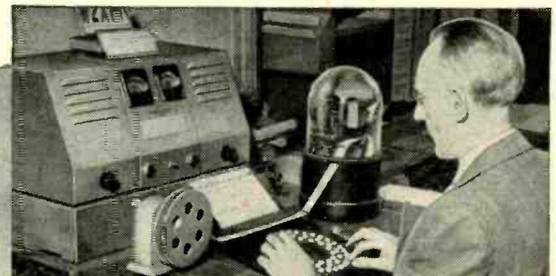

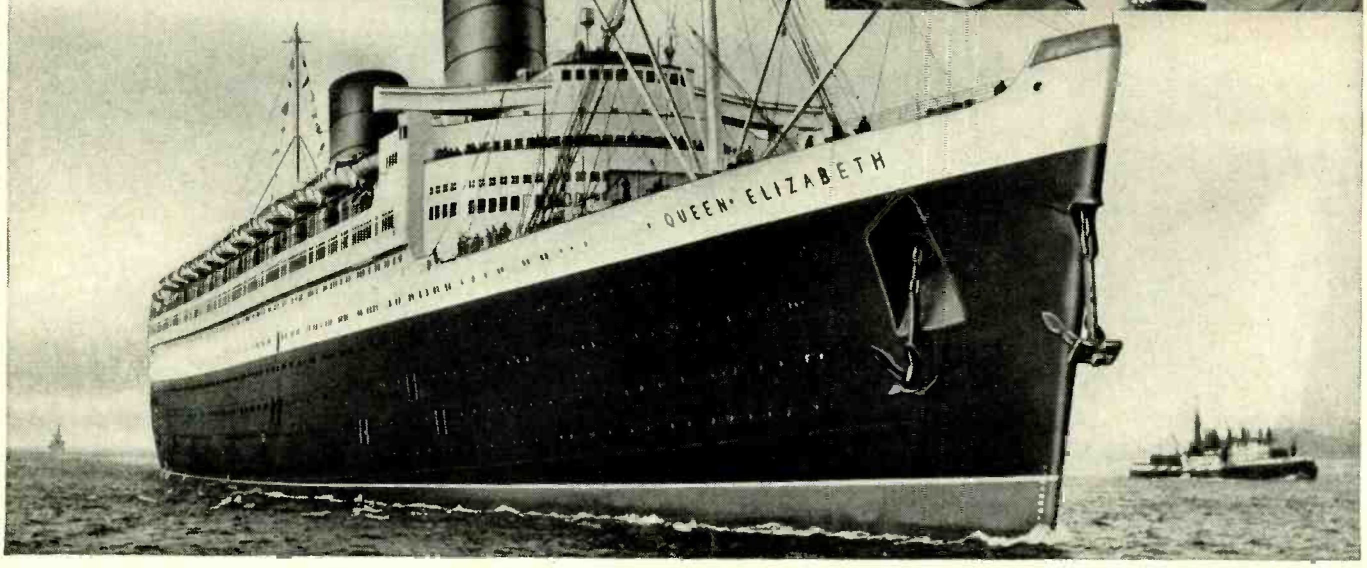

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AUGUST, 1949 — Vol. 33, No. 8

COVER

Photomontage of a human ear (the ear of a six-months-old baby) and a plastic model of the middle and inner ear structures, superimposed on an illuminated disc record. Prepared especially for Audio Engineering by John D. Goodell.

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EDITOR'S REPORT

THE AUDIO FAIR

TO THE AUDIO ENGINEER, the biggest news of the month is the announcement of The Audio Fair to be held October 27, 28, and 29, at Hotel New Yorker, in New York City. Long an orphan in radio-electronics, audio is rapidly becoming recognized as a separate field. With its own exhibit for the first time, this recognition is clinched.

By its very nature, audio equipment must be heard as well as seen—thus differing from the children in the old adage. Only by the use of separate rooms for the demonstration of equipment can the exhibitee be shown—both aurally and visually—the features and performance characteristics of amplifiers, speakers, recorders, microphones, and other components designed to appeal to the auditory senses. The exhibitor acceptance of The Audio Fair has been gratifying, and those who attend are assured of a full coverage of the newest equipment.

Held in conjunction with the first annual convention of the Audio Engineering Society, with several sessions of technical papers, The Audio Fair becomes a milestone in the progress of a new field.

THE NEW JOURNAL

As a result of an election by the members of the Audio Engineering Society, a new section is included in this issue under the aegis of the Society. The Journal of the Audio Engineering Society will be a regular monthly feature of the magazine, and will contain papers presented at various section meetings and at the Convention to be held in October. The first of these papers—already distributed to the members—describes an interesting electronic development in audio measuring apparatus. Next month's Journal paper will describe the well established lateral feedback recording cutter of Bell Telephone Laboratories development. These papers are published in the magazine approximately two months after their distribution to the members in individual folders, thus providing subscribers with the same material available to the members, but at a later date.

We are pleased at our selection as the medium for the publication of the Society's papers, and we pledge our continued presentation of the best available articles on the wide field covered by the term *audio*, which must include psychoacoustics, electronics, architectural acoustics, and system design.

MORE STANDARDIZATION

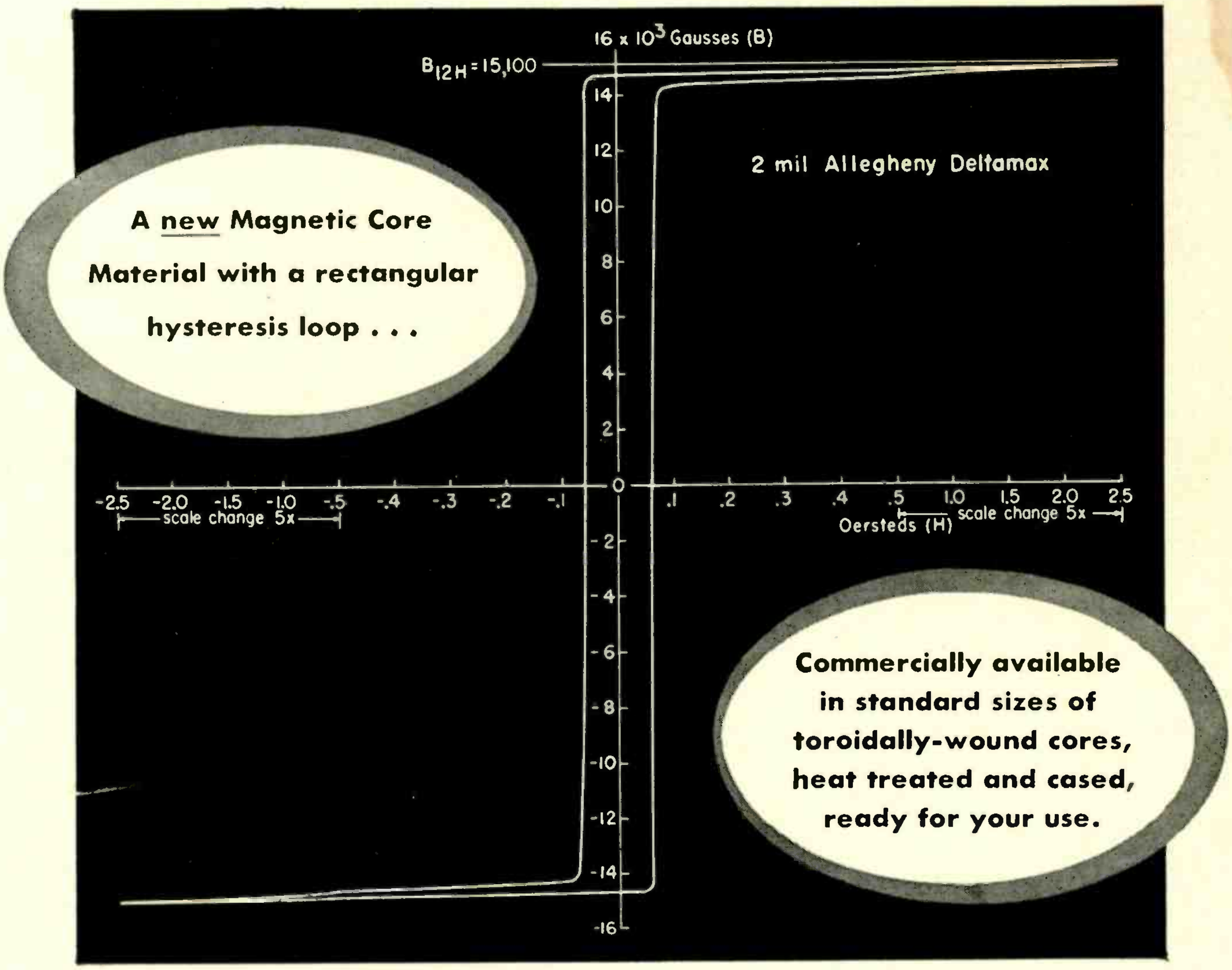
Following our discussion of this subject in the two preceding issues, we are reminded of the activities of several standardization groups who have done commendable work in direction over the past years. These standards have covered practically all broadcast amplifier equipment, and microphones have been standardized just recently.

Most engineers in audio work with broadcast and recording organizations know these standards, and have been working with them since their adoption. But the importance of any standard—regardless of by whom promulgated—lies not in its acceptance by a few, but rather by its universal acceptance. The independent engineer who designs and installs a high-quality public address system far from any broadcast center must know and adhere to these standards if they are to be of the greatest benefit. Even the individual who constructs for himself—as a hobby—a home reproducing system which is equivalent in performance to a broadcast station should also have access to and should follow the standards.

To this end it is desirable that the standards be given the widest possible distribution, and they be made available to anyone who wishes them. If for no other reasons, the saving in cost to manufacturer, jobber, and user should be appreciable because of the reduction of the number of types of equipment required to cover the needs.

The fact that standards exist should certainly reflect credit to those who have been charged with the many hours of committee work, the interminable letter writing, and the inevitable discussions which arise when differing opinions must be adjusted to come out with one specific set of standards. Standards are not plucked, ready-made, from the sky—they represent years of experience and a keen analysis by competent engineers.

DELTAMAX -now available!



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The properties of Deltamax are invaluable for many electronic applications, such as new and improved types of mechanical rectifiers, magnetic amplifiers, saturable reactors, peaking transformers, etc. This new magnetic material is available now as "packaged" units (cased cores ready for winding and final assembly) distributed by the Arnold organization. Every step in manufacture has been fully developed; designers can rely on complete consistency in each standard size of core.

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— Letters —

Microphones

Sir:

I must admit being surprised on reading your report on "New Microphone Designs" in the July issue. Not because of the comments on the desirability of providing new and better microphones but because of the inference that presently available instruments produce far more acceptable sound quality when operated under normal radio conditions than at distances required in television by camera placement.

TV undoubtedly poses new problems in sound pick-up. However, the problem of locating the microphone outside the field of vision of the camera is not new and would seem to be fundamentally the same problem the motion picture industry has handled so well. The sound perspective and over-all naturalness they achieve is refreshing after exposure to the excessive sibilance, characteristic of close radio pick-ups.

In the opinion of this reader the microphone technique of the radio industry, particularly in speech pick-up, has been an important factor in the retention of low-fidelity equipment. It would be a boon to radio, TV and PA if the microphone, when in use, could not be approached closer than thirty inches.

Coke Flannagan
Mountain Lakes, N. J.
110 Lake Drive

Book Review

Electrical Transmission of Power and Signals, by E. W. Kimbark, Professor of Electrical Engineering Northwestern University. John Wiley & Sons, Inc., New York. $6.00.

This textbook presents a study of power, telephone, and u.h.f. transmission approached through classical transmission-line theory. To audio engineers as a group, this treatment will seem unfamiliar because it is not one which is usually employed in the study of communication circuits. However, with transmission lines assuming greater importance with the expansion of a.c. application, the studious-minded engineer will find that the rigorous presentation in this book provides a better groundwork for the comprehension of general circuit theory.

Transmission-line theory can be applied to the analysis of filters and other recurrent networks, and it has long been recognized that it is possible to evaluate performance of any network or circuit simply by a study of the passage of a unit pulse through the system. This is clearly presented by Dr. Kimbark, and the book is cited as desirable for the engineer who wishes advanced study. It is definitely not suitable for the beginner, nor was it intended as such.

Transmission-line (hyperbolic function) charts and a number of tables and graphs of the characteristics of various types of transmission lines and cables are included, and the methods of use are discussed clearly and thoroughly.

MARGIN CONTROL RECORDING BOOSTS MICROGROOVE RANGE

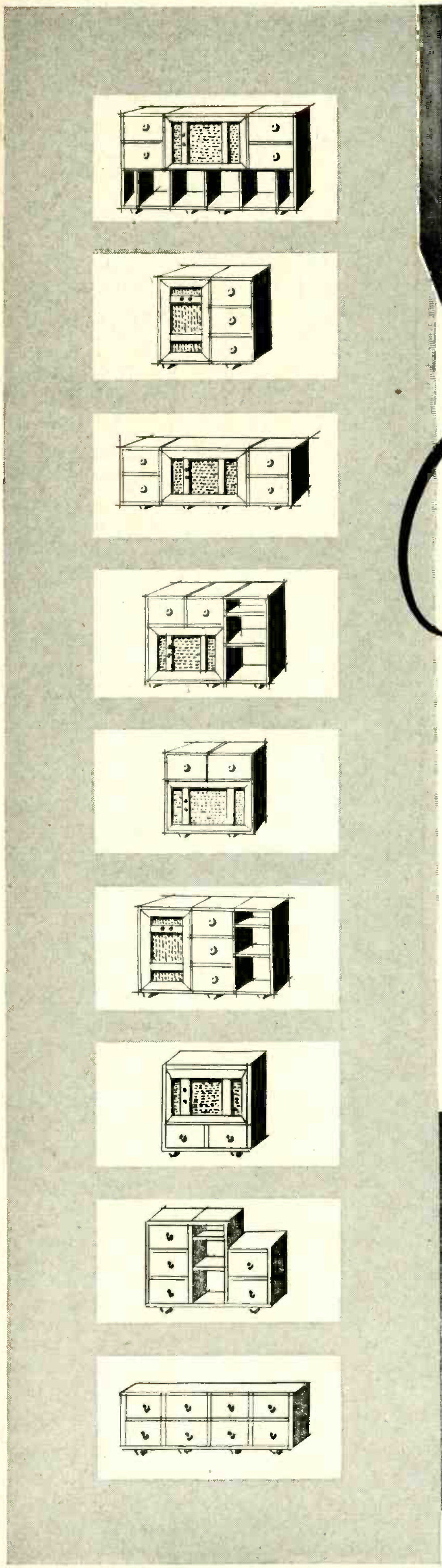
By A. C. Travis, Jr.*

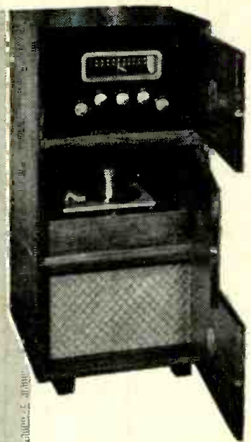
For some time now Mercury Records have carried a little notation on their record envelopes explaining that the recording was done by a special process called, "Margin Control." That many recordists are not familiar with the meaning of these words is evidenced by the fact that we have so many times been asked for an explanation. Credit for the technique goes, according to all indications, to Bob Fine of Reeves Sound Studios. An interpretation of "Margin Control" follows in the form of a quotation from the external house organ of a famous manufacturer of blank records for both master and instantaneous recording.

"It seems that one of the major tactical problems in the ten inch versus seven inch microgroove war is the problem of the crescendo (evidently an old Mexican word meaning a noise that grows so loud it wakes up the customers). Now, when one of these crescendo passages comes along in microgroove recording, naturally the cutting stylus starts beating from side to side with such ferocity, that, while it cuts, it also displaces land material sufficiently to distort the adjoining groove. The resulting echo, even with the best discs, has relegated many master recordings to the reject pile. The obvious remedy of reducing volume cuts dynamic range, but, of course, when an irresistible force meets an immovable object, something has to give. Bob Fine gave—with an idea. He runs through the original recording or live number and "scores" it by plotting VU meter readings against time. Then, using new Fairchild equipment wherein lines-per-inch are infinitely variable from approximately ninety to five hundred, he makes the master fine-line recording by monitoring the lines-per-inch so that spacing is finest on lowest passages, coarsest on loudest ones. Appearancewise this procedure makes, from a light pattern standpoint a funny looking record. For our money a disc recording, however, was always something to be more listened to than looked at. So, Mercury Records seem downright pleased with the resulting 62 db dynamic range."

"Margin Control", according to Mr. Fine, because of the inherent low noise level of the material is particularly effective with Soundcraft 'Maestro' discs. Soundcraft's triple-filtering to remove foreign matter, and Soundcraft's uniform consistency establish wide-dynamic-range microgroove recording on a predictable basis. Incidentally, Soundcraft ads, like Soundcraft discs, are equally effective either way up. Advertisement

*Vice Pres., Reeves Soundcraft Corp.





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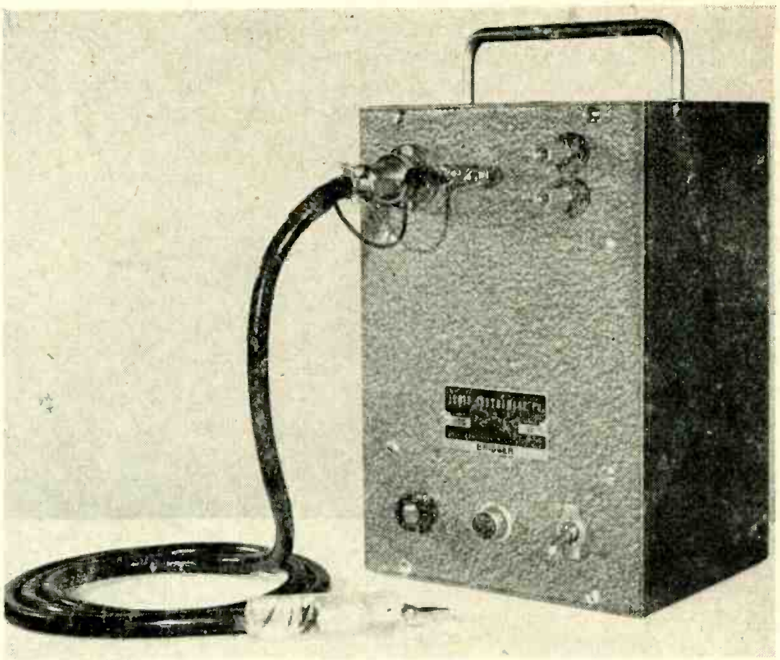
Shown above is Shelf which provides for inclusion of TV receiver or record albums in a CUSTOMODE ensemble.

The Bridger, with its unique double-shielded input cable



C. J. LeBEL*

Loading effects of measuring instruments are readily eliminated by a novel design

Developments in Cathode Followers

OCCASIONALLY WE LIVE with a problem for so long that we stop trying to cure it, and forget that it could be solved. Measuring the operation of a high-impedance electronic circuit without changing its performance falls in this class. Included are measurements of gain, response, and distortion at intermediate points in an amplifier (such as the output of a driver stage).

Besides the matter of loading down the point to be measured, we also must not neglect the introduction of hum. In many cases we have been confronted with choice of a shielded measuring cable and excessive loading effect, or an open wire with no loading but a lot of hum pickup instead.

To see the magnitude of the problem, we examine the following data on input impedance of typical laboratory instruments:

Distortion and Noise Meter	.1 megohm	+ 40 μμf
Wave Analyzer	.2 "	+ 25 μμf
Vacuum Tube Voltmeter	.5 "	+ 30 μμf
Oscilloscope	2 "	+ 30 μμf
Pair of open test leads, 3 ft. long		20 μμf
Coaxial shielded test lead and plugs, 3 ft. long		75 μμf to 200 μμf

Input impedance is given in the form of the equivalent parallel circuit, so that the values tabulated are effectively in parallel with each other, with the connecting lead capacitance, and with the circuit under test. For example, if we bridge a vacuum-tube voltmeter and a distortion meter across the output of a driver stage with open leads to check the origin of some distortion, we would apply 83,000 ohms and 100 μμf of loading. These values are used in the following discussion.

Effect of Instrument Loading

Effect of the resistive component of loading is apparent at a glance in the tube data book. Added after a typical pentode stage, stage gain is reduced 75 per cent, and undistorted voltage output over 50 per cent. A high-mu triode stage is less affected, for gain drops only 50 per cent, and undistorted voltage output only 45 per cent. A low-mu triode is least affected, with a reduction in gain and undistorted output voltage of 10 per cent. These figures are not exact, and are intended only to indicate the seriousness of a condition. They make it impossible to tell exactly what the normal tube operating characteristics are. If applied across a capacitive load (a crystal hearing-aid receiver is essentially equivalent to a .0015 μf capacitor) or if fed through a small blocking capacitor, even the frequency response may be badly altered.

Brief inspection of *Fig.* 1 indicates that the reactance of a small capacitor is by no means unimportant at the higher audio frequencies. A 100 μμf capacitor has a reactance of 150,000 ohms at 10 kc, and only about 100,000 ohms at 15 kc. The effect on the frequency response of a pentode or high-mu triode stage would be very great—a loss of about 10 db at 15 kc and an even greater drop in undistorted out-

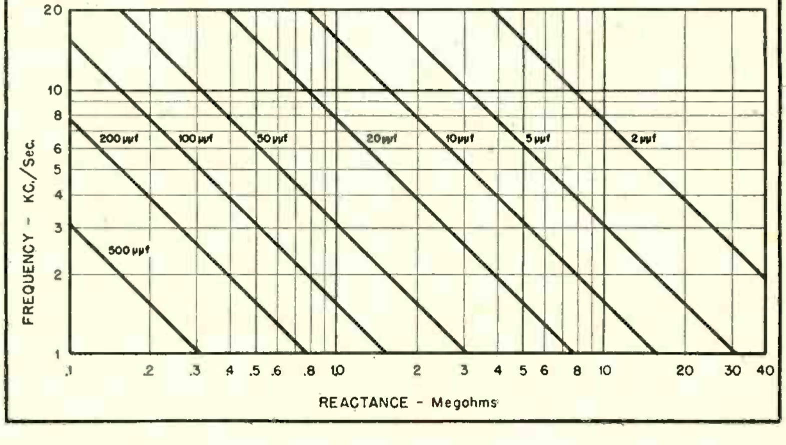


Fig. 1. Reactance of small capacitors.

*Audio Instrument Co., 1947 Broadway, New York 23, N. Y.

put. Even the capacitance of open test leads would be enough to reduce gain by 3 db at 15 kc.

It is evident from these figures that we need some sort of a new translating device which will have an input resistance of many megohms and an input capacitance of a few $\mu\mu$f, even when a three-foot shielded input cable is used. At the same time this new bridging device must have an output impedance of not over several hundred ohms, so that it may feed any reasonable length of ordinary shielded cable, and any reasonable number of measuring instruments, without change in characteristics. With all these properties, it would be a great convenience if input and output voltage were in constant ratio, and even better if they were so closely alike that the difference could be neglected. Finally, a.c. operation is a prime necessity.

The Basic Solution

It will be recalled that in a cathode follower circuit any impedance connected between grid and cathode appears between grid and ground, increased by the cathode follower action. The resistance (using a parallel form of equivalent circuit) appears at the input increased by the factor $(\mu + 1)/1$ and the capacitance appears decreased by the factor $1/(\mu + 1)$.

These are approximate relations, but they serve to illustrate the basic idea. Now the increase of resistance applies to a suitably connected grid leak, as well as to internal tube leakage, and the decrease of capacitance applies to external capacitors connected between grid and cathode, as well as to the internal tube capacitance. We can utilize this principle[1] in the basic circuit of *Fig.* 2. We use a coaxial cable and reduce the effective capacitance between shield and central conductor by connecting the shield to the cathode of the tube.

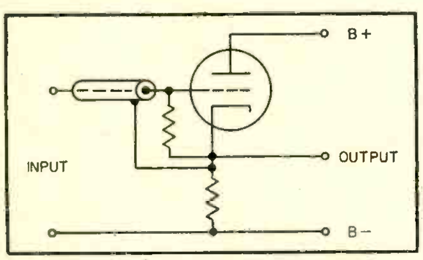


Fig. 2. Basic cathode follower circuit.

To make the circuit practical, two changes are necessary, and one is more desirable. First, we supply grid bias by tapping down a little on the cathode resistor. Secondly, we have to shield this cable by adding a second shield outside the first, to eliminate hum pickup by the inner shield. Finally, we improve the ratios $(\mu + 1)/1$ and $1/(\mu + 1)$ by increasing μ. We have our choice of a high-μ triode, or a pentode, and we use the latter. The circuit changes to that of *Fig.* 3, which includes both actual and equivalent configurations. It can be seen that the capacitance between the central conductor and the inner shield of the cable appears between grid and cathode of the tube, but the capacitance between the inner and outer shields appears as a load across the output. Since a reactive load will tend to limit the performance of a cathode follower, this capacitance must be minimized. Inadvertently, we have gotten ourselves into a new problem in coaxial cable design.

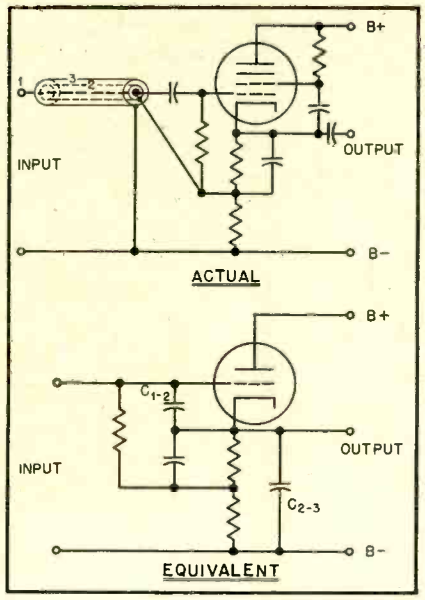


Fig. 3. Practical cathode follower circuit.

The Cable Problem

The fundamentals of coaxial cable design are given in *Fig.* 4. It is apparent that low capacitance can be achieved only by minimizing the dielectric constant K and increasing the ratio D/d. When we come to the actual cable, we have one coaxial within the other, and D_1 of the inner cable becomes d_2 of the outer cable (plus a small allowance for shield thickness). We have a nice problem in design not faced by wartime designers of double-shielded cables. They were able to put the outer shield directly on top of the inner. We have to keep *both* D/d ratios at a reasonably high value.

The effect of varying D/d, for insulating materials of different dielectric constants, is shown in *Fig.* 5. It may be noted, for a dielectric constant of 2, that D/d must be about 4 to give a capacitance of 24 $\mu\mu$f per foot. If we try to hold each capacitance to that value, then *outside D/inside d* will exceed 16. If we use a dielectric constant of 4, then D/d is over 10 for 24 $\mu\mu$f per foot, and *outside D/inside d* will run well over 100.

The physical significance of the latter value needs to be emphasized. If we start with an inner d of .020 inches, the outer D becomes 2 inches—surely a bit large for a test cable. In the writer's own design, values of 30 $\mu\mu$f from conductor to inner shield and 22 $\mu\mu$f per foot from inner shield to outer shield were used as an objective. This made it possible to achieve the small outside diameter, over the jacket, of .350 inches. A high degree of flexibility can be achieved with that outer diameter if the plastic insulation is properly formulated.

We can retain low capacitance at the cable input only if all stray capacitances are made negligible, or are guarded out by a shield driven by the cathode. As applied to the plug, this means that the outer shell is connected to cathode, not to ground. A grounded shield could be mounted on the panel, but we find that proximity of the shell

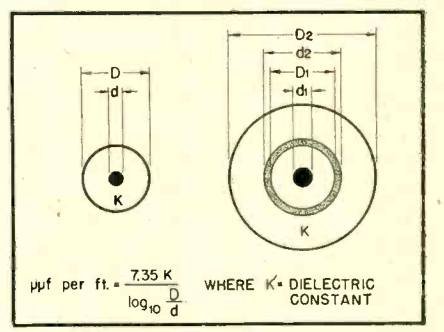


Fig. 4. Coaxial cable design.

to the case is enough to keep its hum pickup down below that of other sources of hum.

In choosing a plug and receptacle, then, we look for a perfection of shielding, not for low internal capacitances. The latter is almost all cancelled out, anyway, by the cathode follower.

Cathode Follower Design

We have designed a good cable, and chosen a satisfactory plug. It remains only to design a good cathode follower. In view of the large number of recent articles on the subject, one should have no difficulty in doing this, but a little review of fundamentals may save much reaching for the handbooks.

The internal output impedance of a cathode follower is, disregarding the cathode resistor, and to a close approximation:

$$R_{out} = I/G_m$$

This tells us, for example, that an output impedance of 200 ohms can be achieved if we will use a tube whose transconductance is 5000 micromhos.

[1] It is believed that this idea was first applied in an experimental microphone circuit at Harvard University during the war.

The input capacitance will be:

$$C_i = C_{gp} + (1 - E_o/E_i)\,C_{gk}$$

where E_0 = output voltage
E_1 = input voltage of follower

Remember that C_{gk} includes the cable and plug capacitance as well as the internal capacitance of the tube. This tells us that 100 $\mu\mu f$ of cable, plug, and grid to cathode capacitance can be reduced to 2 $\mu\mu f$ if we can achieve an output/input ratio of 0.98.

The input resistance will be

$$R_i = R_{gk}\frac{1}{1 - E_o/E_i}$$

This tells us that a 2-megohm gridleak will appear as 100 megohms at the input if we can, again, achieve an output/input ratio of 0.98.

So we find that an output/input ratio of nearly unity is necessary to achieve high input impedance, as well as being convenient of itself. The formula for this ratio is

$$\frac{E_o}{E_i} = \frac{\mu Z_L}{R_p + (1+\mu)Z_L}$$

where Z_L = load impedance

If the plate impedance R_p is very small compared to $Z_L(1+\mu)$, then the formula can be simplified to:

$$\frac{E_o}{E_i} \approx \frac{\mu}{1+\mu}$$

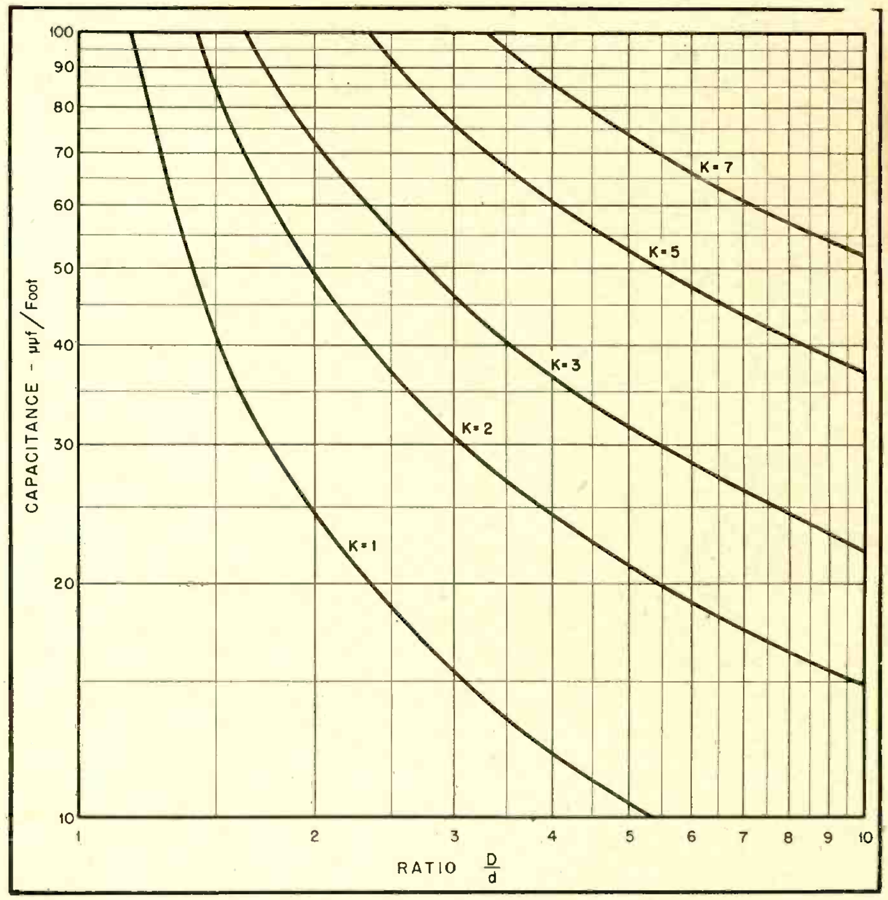


Fig. 5. Capacitance of a coaxial cable.

This is the form which is often cited in discussions. A little computation and experiment will mark it as a useful guide to thinking, but rather inaccurate with pentode tubes and low load impedances.

At any rate, both formulas stress the importance of high tube amplification factor. We can get this with either a high-mu triode or a pentode. If we choose a triode, we find that the highest mu readily available is about 100, accompanied by a nominal transconductance of 1500. A new problem now enters. For a number of reasons, resistance in the cathode circuit is preferable to other coupling means. But unless we use a prohibitively high plate-supply voltage, we are likely to realize only half the data book transconductance, with resistance coupling. So we are going to end up with a transconductance of say 700, and a plate impedance of perhaps 100,000 ohms. This will give a voltage ratio of 0.94, and an output impedance of 1400 ohms. The voltage ratio is far from the 0.98 that we assumed, and we find that 100 $\mu\mu f$ of cable capacitance would look like 6 $\mu\mu f$ instead of 2 $\mu\mu f$.

We can get both higher mu *and* higher transconductance if we will change to a pentode. For example, a 6AC7

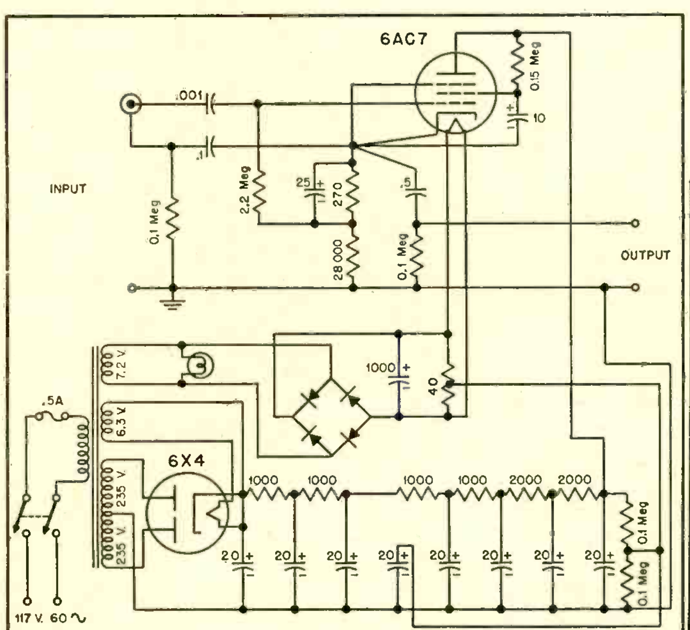


Fig. 6. Cathode follower and power supply.

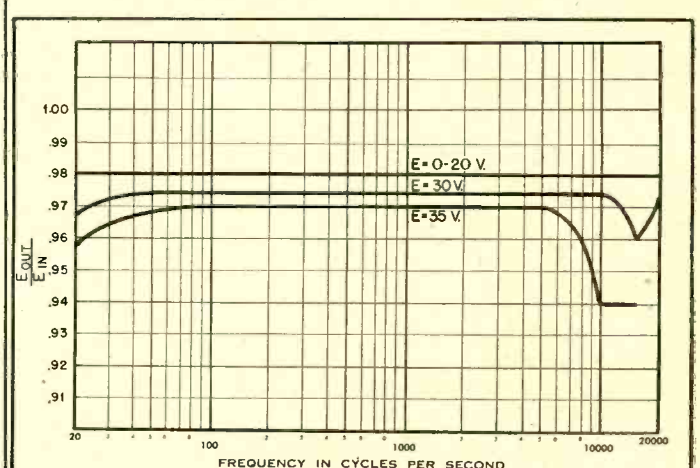


Fig. 7. Frequency response of cathode follower.

Magnetic Tape Erasure by Permanent Magnets

ROBERT HERR*

Applications of d-c pulses may be used to obtain erasure almost comparable to the results possible with a-c bias, providing the conditions are carefully controlled.

For good erasure of magnetic tape recordings, two requirements should be met. The first is complete obliteration of previous signals. This condition is met if, at some time in the erasing process, the magnetic material is saturated in at least one direction. The second requirement is demagnetization of the tape. This is important in order to achieve minimum background noise and minimum distortion in the subsequent recording. This condition is best met by subjecting the magnetic material to a large number of cycles of alternating fields of symmetrical waveform which at some point in the process reach substantial saturation and, thereafter, decrease gradually through many cycles to zero.

A third consideration of some practical importance is that the process be insensitive to the magnetic characteristics of the tape to be erased, so that a given erasing means may be used without change for any of a wide variety of tapes. The alternating field process, with a high enough maximum field, will work on any tape. Some permanent magnet processes will obliterate the signal from any tape, but leave various states of magnetization on various tapes.

Thus from a magnetic point of view, demagnetization by alternating fields is satisfactory, but from a manufacturing point of view it is attractive to erase tape by one or more permanent magnets because such erase offers economy, reliability, simplicity, light weight, and freedom from servicing. This paper discusses some of the points to consider in the use of permanent magnets for erase.

If the erasure is to be followed by recording with d-c bias there is no problem. Here the erase should not be designed to demagnetize the tape but to saturate it, and a single saturating magnet is all that is required. However, with this type of recording, a high noise level is unavoidable and most present day recorders use a-c bias. The following discussion assumes that the erase will be followed by a-c bias recording.

D-C "Pulse" Erasing

With a single permanent magnet of sufficient strength to saturate the tape, the signal may be easily obliterated but the noise level of even a perfect tape would be fairly high and that of actual tapes is very high. For example, noise levels of 20 to 30 db higher than those normally obtained with a-c erase are common. In addition, the polarized condition of the tape leads to serious even order harmonic distortion in the subsequent recording, a condition which is absent with a good a-c erase. The expedient of a "single pulse" permanent magnet (or d-c) erase can therefore be justified only when cost or simplicity is the prime consideration.

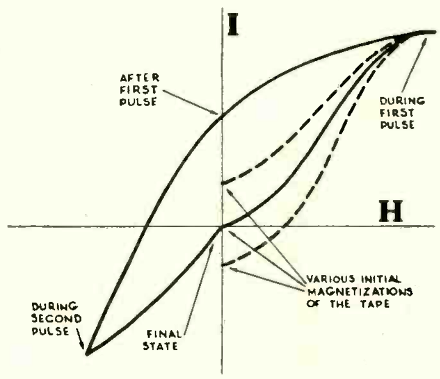


Fig. 1. Curve showing principle of demagnetization by two d-c pulses.

The next step is to consider two d-c "pulses." In principle such a cycle can demagnetize, as shown schematically in *Fig.* 1. The first pulse should be saturating (in either direction); the second pulse is of opposite polarity and of just such strength as to leave the material with zero magnetization after its removal.

At this point several considerations enter:

1. The hysteresis loop of the material which we obtain from any gross measurements represents an average over many billions of oxide particles. These particles are crystals or oriented aggregates of crystals, each of which has preferred axes of magnetization. For a given direction of magnetization, each crystal orientation will result in a different contribution to the observed hysteresis loop. Under these conditions, a cycle of two pulses cannot be adjusted to demagnetize all the particles. However, a gross average of zero magnetization can be obtained, and when it is, the noise will be much reduced from that obtained with one pulse because,

   a.) The magnetization of individual particles, while not zero, will likely be less than that resulting from saturation, and

   b.) Noise resulting from tape irregularities of relatively long wave length will be effectively reduced.

2. Any given erase will not be optimum for a variety of tapes, although it may be better than a single-pulse erase for all of them.

3. In actual use, the tape when heard has passed not only the erase head but also the record head. In this process the bias field acts on the tape, even when no audio is recorded. Thus the demagnetization result discussed above is of purely academic interest. What is important is the condition of the tape after erasure and biasing. In biasing, the tape is subjected to an a-c field of increasing and then diminishing strength. For a demagnetized tape the bias (if of good design) changes conditions very little, but for a tape erased by one or a few d-c pulses the change may be considerable. To some extent the bias field acts as an incomplete (i.e., non-saturating) a-c erasure and tends to reduce noise. It may, however, tend to alter an average tape magnetization from the zero value in which a permanent magnet erase cycle left it, and thus tend to increase noise. This will be made clear below.

A characteristic of a tape in which an average zero magnetization has been achieved by a few d-c pulses is that it is composed of a collection of particles all of which may be magnetized. If a small a-c field is applied and gradually reduced to zero, it may demagnetize some of these elements or alter some

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

domain boundaries that are relatively unstable, while not affecting others. When this happens the average magnetization is no longer zero.

Method of Obtaining Data

To take quantitative data, a large solenoid was used to apply known fields to a ¼-inch square rod, 12 inches long, of oxide dispersion. The magnetization was measured by passing the rod through a pickup coil connected to a ballistic galvanometer. A d-c pulse was administered by setting the desired current from storage batteries in the magnetizing solenoid and passing the rod through the solenoid. Diminishing a.c. fields were obtained in the same way, using a 60 cycle supply with a Variac. The diminishing was done by the movement of the rod rather than by the Variac. After each pulse of d.c., the magnetization of the rod was measured, and after a suitable erase schedule, the rod was subjected to a-c fields and measured after each "shake" beginning with weak and increasing to saturating a-c fields. The units for magnetization were left arbitrary, although they could be converted to absolute values of flux lines or gauss; the field values were measured in oersteds.

The data are summarized in *Fig.* 2. The schedules of d-c fields used to erase are shown at the left for erasures of from one to five d-c pulses. Beneath each pulse applied is tabulated the residual flux, measured following that pulse. To the right of each schedule is plotted the magnetization as a function of the peak value of the a-c field to which the sample was subjected after erase.

Leaving aside the bottom curve, the curves form a family which illustrate the basic phenomenon. The top curve is a single-pulse d-c erase, which leaves a large magnetization which is hardly reduced by ordinary bias fields (of the order of 200-300 oersteds). The next two curves show two-pulse erasures with obvious improvement over the single-pulse erase. The first of these achieves zero average magnetization after erase, but the a-c field corresponding to the bias increases the magnetization very markedly. The second of these two shows an erase so designed as to leave zero magnetization after biasing with 280 oersteds. Various three, four, and five pulse erasures follow and it may be seen that:

1. Gross, or average, magnetization may be made no more complete but enormously more stable by increasing the number of pulses in the erase schedule.
2. One can alter the shape of the curves deliberately and predictably by choosing the sequence of pulses. As the a-c field is increased following a multi-pulse d-c erase, the material retraces its past history, "forgetting" first the last or weakest d-c pulse, then the next to last, and so on. This shows the extent to which the erase schedule failed to demagnetize the material and achieved instead merely a zero average flux, as described above.

Experimental D-C Pulse Head

The schedules shown are, of course, not all the data taken. For a given result the magnitude of pulses had to be chosen with great care. In practice, one of the fields from commercial magnets could not be controlled within the fraction of one per cent necessary to get the results shown for a five pulse erasure. A magnetization of 10 to 25 units on the vertical scale of the curves would be a good practical result.

Another factor of great importance in actual tape erasure is that fields applied to the tape are not uniform through the tape. Thus for a given array of magnets the layers of tape next to the magnets might experience fields proportional to but stronger than the fields acting on a more remote layer of the tape. The last curve of *Fig* 2 illustrates the inadequacy of a five-pulse schedule which is similar to the one directly above it but with all values increased by the factor 1.86. It does a poor job, and if one must contend with such variations, either more pulses must be used or poorer results expected.

The schedules shown in *Fig.* 2 are also non-universal with respect to the magnetic properties of the tape. A schedule best for one tape will not be best for another, although it will be better than a single pulse. Universality is necessarily tied in with a very large number of pulses such as approximate true demagnetization.

In actual tape recording, not only are there gradients in the erasing fields but also in the biasing field. For conventional ring-type record heads, the bias-field gradient across the thickness of the tape may introduce a factor from two to five between the fields near the front and back of the tape. Thus

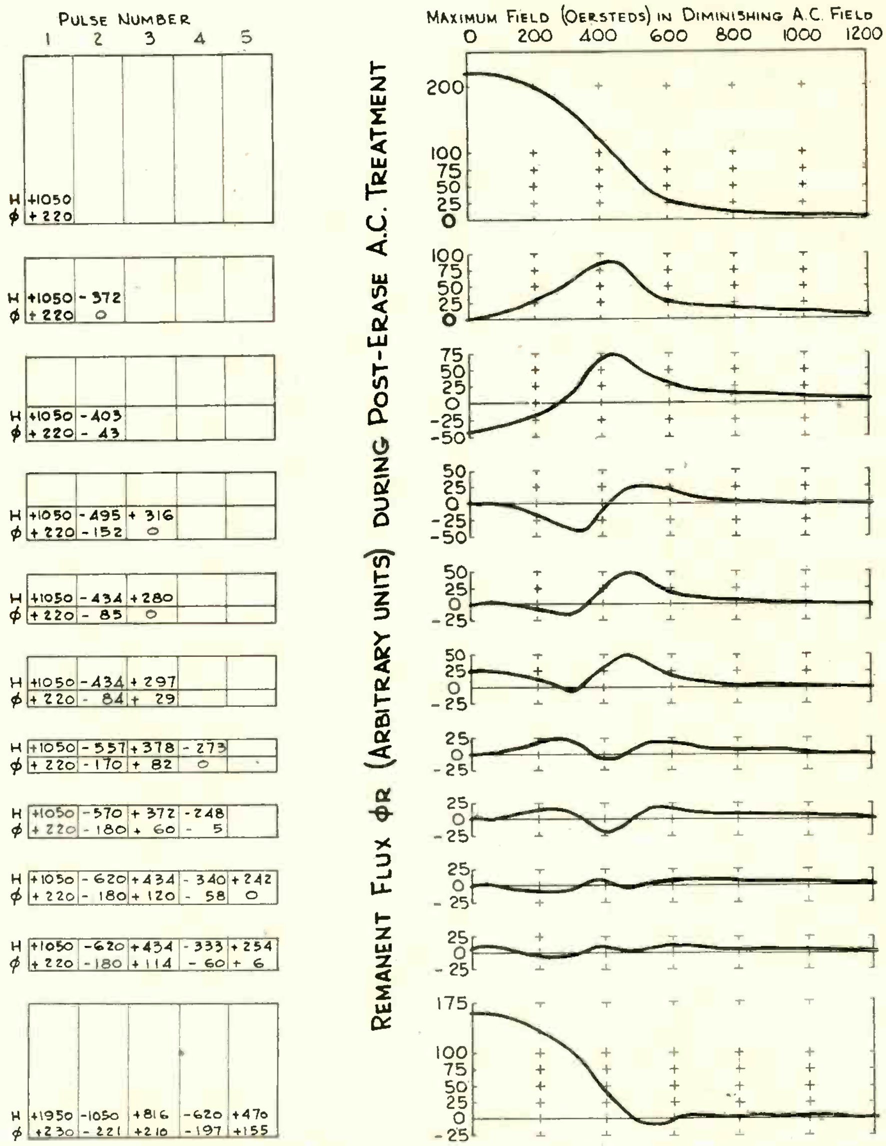


Fig. 2. Chart showing characteristics of erasure by various schedules of d-c pulses, using rods as the magnetic medium.

committee. They hold 33 minutes of tape at the standard speed of 15 inches.

Three motors are used in the drive system, one a dual-speed synchronous motor to drive the capstan, and the other two on the reel assemblies. All motors are very compact and light in weight, having been especially designed to Ampex specifications. The turntables holding the tape reels are attached directly to the shafts of the rewind and takeup motors. A holddown is used to lock the reels in place. The holddown is constructed in such a manner that it centers and locks the standard NAB reel, as well as the standard RMA reel, without regard to varying thicknesses. Motor shafts 5/16″ in diameter allow the use of the smaller RMA reel. Mechanical brakes are employed for providing quick smooth stops at any speed without undue tape tensions and without allowing slack to form at any time.

The drive system was the subject for the most intensive investigation of any part of the machine. Many different types of drives were built up and studied. The various factors which produce speed variations were isolated and analyzed, and methods of construction were devised which eliminated their effect. The result is a remarkably wow-free and flutter-free drive, with a minimum of precise, close-tolerance parts. The fact that speed variations have been removed by basic design principles rather than by excessive precision in manufacturing has greatly reduced the cost of the drive unit.

Another feature of the drive system is instant starting. When the tape is threaded up, the takeup tension arm is moved into position, which starts the capstan motor. This same arm also automatically stops the machine when the tape runs out or in the event of tape breakage. When the START button is operated, a rubber idler clutches the tape against the capstan and the tape comes up to speed in less than 0.1 seconds. This feature is useful in editing and in cueing programs.

The following pushbutton controls are provided: START, STOP and RECORD. Since these controls are relay operated, they may be governed from a remote location. A selector switch controls the mode of operation, either NORMAL PLAY, REWIND, OR FAST FORWARD. The machine can be readily shifted from one mode of operation to the other, except that in returning to NORMAL PLAY from fast winding, the machine automatically stops to avoid breaking the tape by clutching it into the capstan while moving at high speed. The ability to shift back and forth at will from REWIND to FAST FORWARD assists in editing operations, as the tape can be shuttled back and forth over a given length to determine the exact location of a particular point in the program.

Head Housing

New heads have been designed which have improved performance characteristics with smaller physical size. Because of the extremely short wavelengths at the high extreme of the audio spectrum at the lower tape speeds, extreme precision in head construction is required to insure interchangeability of recordings on various machines without loss of high frequencies. While a slightly curved gap does not affect the performance of a single machine (the gap effect is readily equalized), such curvature will make it impossible for a group of machines to be aligned so that recordings can be indiscriminately interchanged among them without high-frequency discrepancies. An indication of the accuracy required may be illustrated by the fact that if one edge of the gap is displaced from its proper position by .0003 inches, the response at 15,000 cps will fall off by 2 db. Precision methods of manufacture, combined with the most rigid inspection procedures, assure that the heads will have the required uniformity.

The head housing is a complete plug-in unit containing erase, record and playback heads. Separate record and playback heads retain the valuable feature of allowing direct monitoring

[*Continued on page 30*]

Fig. 3. Model 300 recorder (left) beside the Model 200, illustrating the reduction in size in the new unit. Also shown is the extended-range speaker system used for critical listening tests. The unique Smith-Selsted tweeter (center) provides flat response up to 20,000 cps.

Problems in Audio Engineering

LEWIS S. GOODFRIEND*

Part IV. A study of sound waves—their characteristics, and their transmission; and an introduction to the wave equation, which governs their propagation.

THIS ARTICLE begins the study of sound waves and their generation and transmission. To establish a starting point we shall define sound and some of its characteristics. According to the "Proposed American Standard Acoustical Terminology," published by the American Standards Association for trial and study, "Sound is an alteration in pressure, stress, particle displacement, particle velocity, etc., which is propagated in an elastic material, or the superposition of such alterations." It may also be defined as ". . .auditory sensation which is evoked by the alterations described above." Since fundamental laws of physics relate the various types of alterations, one of them—pressure—will be discussed and the material then extended to cover the others. Also, a discussion of the superposition of alterations will be left until later.

If a pressure measuring device is placed in the path of a musical sound wave the oscillogram of *Fig.* 1 may be obtained. In order to carry on the analysis of propagation various labels have been placed on the figure and their definitions given below. Those marked with an asterisk are from the proposed American Standard.

Static Pressure*: The static pressure is the pressure that would exist in the medium with no sound waves present. The commonly used unit is the microbar.

Instantaneous Sound Pressure*: The instantaneous sound pressure at a point is the total instantaneous pressure at the point minus the static pressure. The commonly used unit is the microbar.

Maximum Sound Pressure*: The maximum sound pressure for any given cycle of a periodic wave is the maximum absolute value of the instantaneous sound pressure occuring during that cycle. The commonly used unit is the microbar.

Note: in the case of a sinusoidal sound wave this maximum sound pressure is also called the pressure amplitude.

Peak Sound Pressure*: The peak sound pressure for any specified time interval is the maximum absolute value of the instantaneous sound pressure in that interval. The commonly used unit is the microbar. Note: in the case of a periodic wave, if the time interval considered is a complete period the peak sound pressure becomes identical with the maximum sound pressure.

Effective Sound Pressure* (Root-Mean-Square Sound Pressure): The effective sound pressure at a point is the root-mean-square value of the instantaneous sound pressures over a time interval at the point under consideration. In the case of periodic sound pressures, the interval must be an integral number of periods or an interval which is long compared to the period. In the case of nonperiodic sound pressures, the interval should be long enough to make the value obtained essentially independent of small changes in the length of the interval. Note: the term "effective sound pressure" is frequently shortened to "sound pressure."

Periodic Wave: A periodic wave is one in which the values of the pressure amplitude recur for equal increments of time or distance, as shown in *Fig.* 1.

Fundamental Frequency*: The fundamental frequency of a periodic quantity is the frequency of a sinusoidal quantity which has the same period as the periodic quantity. The fundamental frequency of a periodic quantity is also the reciprocal of the period.

Period: The period of a periodic quantity is the smallest value of the increment of the independent variable for which the function repeats itself.

Wavelength*: The wavelength of a periodic wave in an isotropic medium is the perpendicular distance between two wavefronts in which the displacements have a phase difference of one complete period.

Figure 2 shows a circular piston having a plane face, moving in a cylindrical tube. The far end of the tube may for the moment be considered to be completely sound absorbent. This will eliminate any necessity to consider reflections. As the piston moves to the right it compresses air immediately in front of it. This small element of air then compresses the air to its right, thereby sending the compression down the tube. If the displacement of the piston takes place in a short time a steep front pulse will be sent down the tube. A picture of the pulse at successive intervals of time is shown in *Fig.* 3.

If the piston is moved to the left the air immediately in front of it will be

*Rangertone, Inc., 73 Winthrop St., Newark 4, N. J.

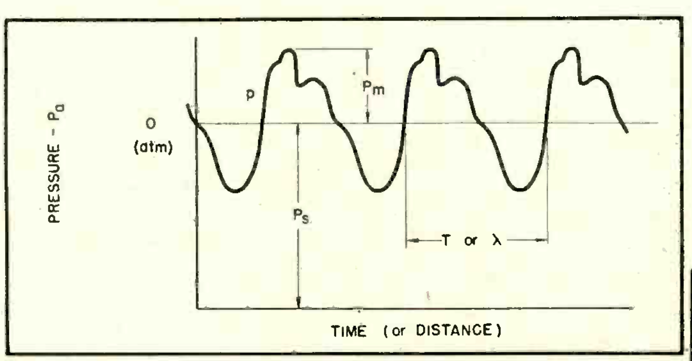
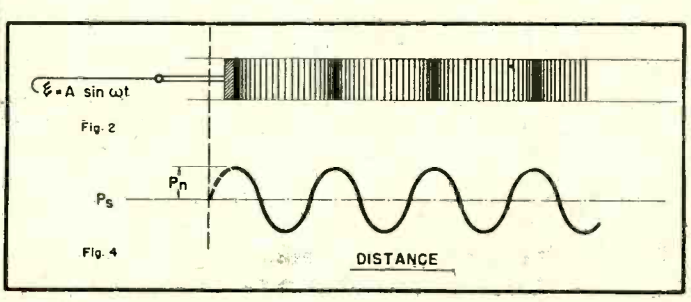


Fig. 1. Oscillogram of a sound wave.

P_a = absolute sound pressure measured above zero
P_s = static sound pressure
p = instantaneous sound pressure
P_m = maximum sound pressure   λ = wavelength
T = period   ξ = displacement

Fig. 2. Pressure and rarefaction waves in tube excited by piston with plane surface.

Fig 4. Instantaneous pressure along tube as result of oscillating (sinusoidal) motion of piston of Fig. 2.



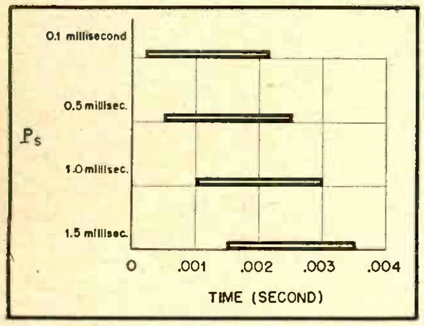


Fig. 3. Movement of pressure wave down tube of Fig. 2.

rarefied and a rarefaction wave will be sent down the tube.

If the piston is driven by a mechanism which will impart to it a sinusoidal motion the pressure in the tube after a short time will vary sinusoidally with distance, as shown in *Fig.* 4, as a train of waves is sent down the tube. Since the waves are being generated by a plane surface, it may be seen that the pressure in any one plane parallel to the piston face, neglecting the frictional drag near the surface of the tube, will be equal, so that the waves are said to be plane waves.

Plane waves and the theory of their propagation offer an excellent means of analyzing many audio problems. They permit simple studies of loudspeakers, the transmission of sound through panels, sound at long distances from the source, and sound in bars and rods.

As an example of plane waves in bars consider what happens when a steel bar is struck on the end with a hammer. When a thin circular plate is struck in the center, waves similar to those in the tube are sent out through the plate in all directions, but they are restricted to the plate. This is a case of a two-dimensional wave and is illustrated in *Fig.* 5. When a source of sound radiates in all directions, three dimensional or spherical waves exist as is shown in *Fig.* 6, and in the simplest form would consist of a small hollow, spherical ball fed with air through a small tube. As the sphere gets larger and smaller it successively compresses and rarefies the air. If we place a loudspeaker on the outside wall of a building and measure its radiation pattern we can see that it will generate spherical waves over a hemisphere.

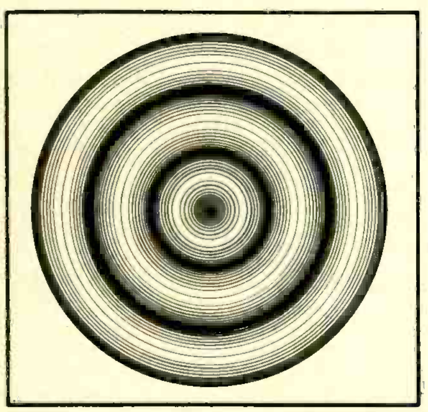


Fig. 5 Showing pressure and rarefaction in two-dimensional sound wave.

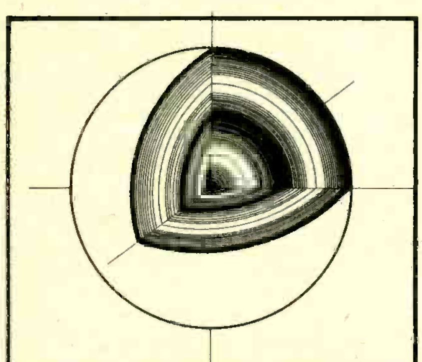


Fig. 6. Pressure and rarefaction existing in a three-dimensional sound wave.

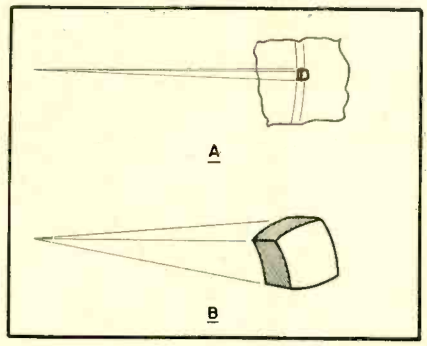


Fig. 7. Elements of pressure waves in (A) two-dimensional plane, and in (B) three-dimensional space.

The extension of plane wave theory to both the spherical and two-dimensional cases simplifies many problems and greatly reduces the mathematical work involved. If we examine portions of the spherical wave and two-dimensional wave at long distances from the source as shown in *Fig.* 7, we see that a small element of either is very much the same as an element of the plane wave, and it is possible to prove this extension mathematically.

Some of the properties which we would like to know about sound waves are: velocity through the medium, velocity of the particles of the medium, particle amplitude, pressure (rms or peak), energy, and intensity. From the physical and thermodynamical principles of continuity, adiabatic expansion and compression gases, and the equation of motion, it is possible to derive an expression relating the particle characteristic under study (displacement, pressure, etc.) to the distance the wave travels down the tube and to time. This equation is the so-called wave equation, and for pressure in plane waves the form

$$\frac{\partial^2 p}{\partial t^2} = \sqrt{\frac{\gamma P_s}{\rho_s}} \quad \frac{\partial^2 p}{\partial x^2}$$

The constant term, which we may call c, may be shown to be the velocity with which the wave travels down the tube. It is also the velocity of waves propagated in either two or three dimensions. In the wave equation the symbols are as follows:

P_s = Static pressure in dynes per square centimeter
ρ_s = Static density of the medium in grams per cm^3.
γ = the ratio of the specific heats of the gas (1.4 for air at room temperature)

Assuming that the displacement ξ varies sinusoidally according to $\xi = a \sin(\omega t - 2\pi x/\lambda)$, a generalized form for sinusoidal motion, the particle velocity u may be obtained from the above expression giving

$$u = \omega a \cos(\omega t - 2\pi x/\lambda) \text{ cm. per sec.,}$$

with the maximum particle velocity $u_m = \omega a$ cm. per sec. The maximum particle amplitude is $\xi_m = a$ cm.

The instantaneous pressure in the wave can be determined from the other quantities giving

$$p = p_s \gamma k a (\cos \omega t - k x) \text{ dynes per cm}^2.$$
where $k = 2\pi/\lambda$.

Determining the energy density (energy per unit volume) in the wave involves the use of calculus, but when the operation is performed we obtain the following expression:

$$E = \rho_s u_m^2/2 \text{ ergs per cm}^3.$$

If we rearrange some of the terms and make the correct substitutions it is possible to obtain the energy equation in another form, $E = \rho_o u^2$ ergs per cm^3. The total energy in a given volume may, of course, be obtained by multiplying the energy density by the volume.

Finally, the intensity of the sound is obtained by multiplying the energy [*Continued on page 31*]

TABLE I

1 microbar	= 1 dyne per cm^2.
1 dyne per cm^2.	= 1.45×10^{-5} lbs./in^2.
1 erg	= 1 dyne-centimeter
	= 7.38×10^{-8} ft. lbs.
1 erg per sec.	= 1×10^{-7} watts
1 erg/sec./cm^2.	= 1×10^{-7} watts/cm^2.

TABLE II

For air at 20° C. and 760 mm. pressure

P_s	= 1.013×10^6 dynes per cm^2.
ρ_s	= 1.21×10^{-3} grams per cm^3.
γ	= 1.40 (dimensionless)
c	= 34,300 cm. per sec.

RECORD REVUE

EDWARD TATNALL CANBY*

SOME MONTHS BACK I went over the LP record as it then appeared to me, while waiting for the 45-rpm RCA record to take its place beside it. Finally, months later, my RCA player has arrived and is in full use and—perhaps a bit late and anticlimactically—I'm in a position to make similar remarks on the second type of record. My player, incidentally, has been encased by RCA in a superb brass-bound mahogany box, affectionately dubbed the Humidor by all concerned; its vital parts however include a diamond point GE cartridge which allows me to make far more accurate comparisons than would the standard crystal cartridge, since I can play all types of records through a single preamplifier and thus pin down a number of factors, in order to judge variations in recording curves, etc. as the ear hears them. (RCA also provides its own preamplifier which I will use alternatively in order to get the "official" equalization as chosen by the company itself. This unit is actually two preamplifiers, one being for the low-level 45-rpm records and the other, apparently, for playing standard records via magnetic pickup.)

If it were a question of black and white (as it must be for some people) I would choose LP over RCA 45 without hesitation, for the *classical* field of music, on numerous counts. But it is far from a black and white matter, and in any case, every so often us classical guys must admit we're only a backwater in the business, even if an important one. I can see where most people who habitually play single records, of which there are millions (both records and people) would find the unlimited choice of program offered by the RCA changer system decidedly preferable to the fixed-choice necessary with the long playing record. Nor are all single records popular, by any means. Huge numbers of singles in the classical field, notably in opera and in celebrity recordings, are sold every year. This is a genuine point in favor of the 45-rpm short record which nobody will deny.

As for the rest of classical music, it is clear to me that if LP had never been heard of, the new 45 system would represent a clear improvement in many respects within the established system of 4-minute recordings. The records are cheaper, unbreakable, enormously more economical of space, and so on. Who could deny this? The disadvantages of the 45 records are mostly of a sort that, like similar troubles with LP, can be remedied in time. The system itself, including the simplified center operating change mechanism, is basically sound—again as a variation upon the systems already in use for 78-rpm records. The idea of LP aside, granting that one is to stick to the standard-length record time (and that is the basic decision) I can't think of any aspect of the 45-rpm system that can be seriously criticized in principle. Even the speed—once more, granting the same premise, that standard-length records are to remain, is not unreasonable and can, I'd say, be fairly cited by Victor as an excellent, if not the best speed—all factors considered—for this playing time. The advantages of the 45 speed over the 33 in the case of the 7-inch record are fairly clear when the Columbia small record is stacked up against the RCA. The Columbia, as far as I can see, wastes space and even so comes pretty close to the center for the slower speed. It would seem that as both size of record and rotational speed are reduced, the various factors do in fact tend to converge upon one speed as optimum. It might have been 50 or 55, with another record size, but, *given these conditions excluding any other than standard playing time*, 33 would most likely be too slow. External reasons, such as the prevalence of 33 in existing equipment, would have to be applied to justify that speed for any standard length record and here RCA would surely be right in saying that this is an attempt to establish a new home standard, optimum for the conditions. Why use a professional speed which is both irrelevant and unsuitable?

Here, then, is the point that most needs clarifying—before any question of practical operation of the new records and equipment is even raised. The basic question was from the beginning—shall we stick to standard playing length, and thus be able to duplicate all existing and forthcoming recordings in the 78-rpm form and on the new form? Or shall we give up this uniformity and produce some other length of play, necessitating two entirely different forms of release for each recording, plus the patching together of all present recordings, or alternatively, the breaking up of longer ones to fit the 78-rpm length? On this question primarily the break occurred not on details, not even on which technical system is potentially better audio—the subject of an enormous amount of engineering talk these last months!

For, once the basic break has been made, once the standard record length has been given up—then the Columbia line of argument comes into force: given *this* condition, what combination of factors works out best—what record size, what length of play, what speed? Given *this* condition—the 78-rpm length of play entirely abandoned, then the 12-inch and 10-inch records at 33 become quite reasonable. Again, perhaps other sizes and other speeds might have been possible, but if one gives up the standard play length, the new length must be significantly longer or the change is utterly pointless; significantly longer means a lot more than even double-play. To succeed, one must, in this case, go the whole hog, and the whole hog appeared to be the present LP, which has abundantly justified its daring, whereas a shorter long-play record, however fine in quality, might have fallen horribly.

I harp on this because it seems to me that minor technical differences and troubles have taken up too much of our thinking these days; most of them are possible to cope with within the two existing systems; it is the basic systems themselves, as conflicting principles, that count most. However, let me enumerate some RCA-Victor characteristics as presently showing themselves to me in the actual playing.

My impression is that the RCA recordings on 45 are considerably less, shall I say, *temperamental* than the LP recordings. The LP's vary greatly in many respect's not only in plain good and bad but in *apparent* recording characteristic, to be compensated for by ear-controlled equalization, and other technical matters. There are a good many inherent wobbles in some spots on the LP's, and various minor imperfections such as "ghosts" (echoes) in adjacent grooves, occasional over-cut passages that on some equipment do not track, and so on. The 45's seem to me inherently more stable and, with the faster speed, this would seem reasonable. The degree of apparent distortion, too, seems to vary greatly from LP to LP—though I know enough by now to suspect equipment no matter how expensive, first, the record last. (I try LP's on several quite different types of playing equipment for this reason. (It is perhaps beyond my

[*Continued on page 34*]

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

This page should be printed in delicate pink this month, reflecting this department's slight embarassment at a colossal injury done to a gentleman named Koechel—*not* Koeschel, as one of our knowing readers pointed out to me! (You'd be surprised at the readers this magazine has acquired in the non-audio fields. We have to watch our P's and Q's hereabouts.) My only defense, such as it is, comes in the accepted fact that *most* German names that involve *sh* sounds use the sch spelling and I took same for granted. Maybe it was that the usual form is just plain "K.", which dodges the issue. (See AUDIO ENGINEERING for June—also once in the July issue; too late to catch it.)

The Journal of the

AUDIO engineering society

Containing the Activties and Papers of the Society, and published monthly as a part of AUDIO ENGINEERING Magazine

Audio Engineering Society, Box F, Oceanside, N. Y.

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Message from the President

For some time the need for a professional society devoted exclusively to audio engineering has been evident. By the beginning of 1948 opinion had become so unanimous in this respect that it became possible to form such a society. In the short time which has passed since then, the Audio Engineering Society has succeeded in accomplishing many things.

Monthly meetings are held regularly by a number of local sections, with papers being read which pertain to specific phases of the audio engineering art. In New York this spring, a series of lectures on "Elements and Practices of Audio Engineering" met with marked success, and other sections are planning to repeat it. A similar series on all phases of recording and reproduction is now being announced for this fall. During October, in conjunction with our first annual convention, The Audio Fair will be held in New York with exhibits and papers marking the activities.

With this issue of AUDIO ENGINEERING magazine, the Journal of the Audio Engineering Society makes its bow, marking one more progressive step taken by the Society.

As president of the Society, I look forward to increased activity in the coming months and years as the field of audio engineering attains the independent recognition which is justly its due.

C. J. LeBel

Coming to the Audio Fair?

Providing for the first time a suitable exhibition medium for the demonstration of audio equipment, The Audio Fair which opens at the Hotel New Yorker on October 27 will give audio engineers an opportunity of both seeing and hearing the new equipment which will be presented on the exhibit floor. Coupled with the first convention of the Society, together with important papers and the installation of officers for the following year, The Audio Fair merits the interest of all.

MANY PROMINENT MANUFACTURERS of audio equipment are, and will be there to reveal their latest developments and to demonstrate their equipment. The Audio Fair—the first exhibit ever held exclusively for the audio industry—will be held in conjunction with the annual meeting and convention of the Audio Engineering Society at Hotel New Yorker in New York City on October 27, 28, and 29, 1949.

The entire sixth floor of the hotel has been reserved for the exhibits, guaranteeing each exhibitor and those in attendance an opportunity to see and hear the new products with a minimum of interference. Some of the nation's leading commercial organizations have already indicated their intention to display their products.

In connection with the exhibit, the Society will hold technical sessions on each day of the meeting, with many significant papers already scheduled for presentation. In addition, a banquet will be held on the evening of October 27. No registration fee will be charged to anyone wishing to attend the exhibits, nor to members for admittance to the technical sessions. Non-members may attend the papers sessions on payment of a small registration fee.

Several unusual projects are being prepared for the Audio Fair—projects which will hold a high degree of interest for those whose primary interest is in the field of audio engineering. As these plans reach maturity, they will be announced in detail in this space. Already slated for an important part at the meeting is the subject of recording—disc, film, and magnetic. High-fidelity sound reproduction and public address equipment will also be demonstrated and discussed.

Mark down the time and place to meet other members of the Society for an absorbing insight into the latest developments in the field of audio engineering—plan now to attend The Audio Fair on October 27, 28, and 29 at Hotel New Yorker, in New York City.

Employment Service

Starting with the September issue, The Journal is inaugurating a free employment service for members and for industry. The service will consist of listing brief announcements of available personnel and positions. If you are either a member of the A.E.S. seeking employment or an employer looking for an audio engineer, The Journal will print, free of charge, a brief announcement describing yourself or the position. Anonymity will be preserved by the use of box numbers for reply. To avoid errors due to rewriting, please compose these notices carefully and keep them brief. Notices for the next issue must be in before August 10. Send them to AUDIO ENGINEERING Magazine, Attention AES Editor, 342 Madison Avenue, New York 17, N. Y.

A New Electronic Audio Sweep-Frequency Generator

By H. TOOMIN*

Optimum presentation of frequency-response data on a 'scope screen requires a special form of a-f signal generator. Circuit details of such an instrument are outlined by the author.

An audio sweep frequency generator is an instrument designed primarily to make possible the presentation of audio frequency response curves on a cathode ray oscilloscope. Several approaches to this problem have been made in the past [1,2,3] with results excellent in the high-frequency register but which have left much to be desired in the presentation of the bass response. *Figure* 1 shows a typical trace for a flat system using a commercial sweep generator. It is apparent that even though the system measured is flat to below 40 cps, there is very little information presented for frequencies below 500 cps. The most obvious fault with the presentation of *Fig.* 1 is the spacing of the cycles. The spot moves at a uniform rate across the screen so that just as much time is spent in traveling from 40 to 50 cps as is spent between 4000 and 5000 cps. Consequently, comparatively few cycles appear in the initial portion of the oscillogram. The wavelength or the distance between cycle crests is approxi-

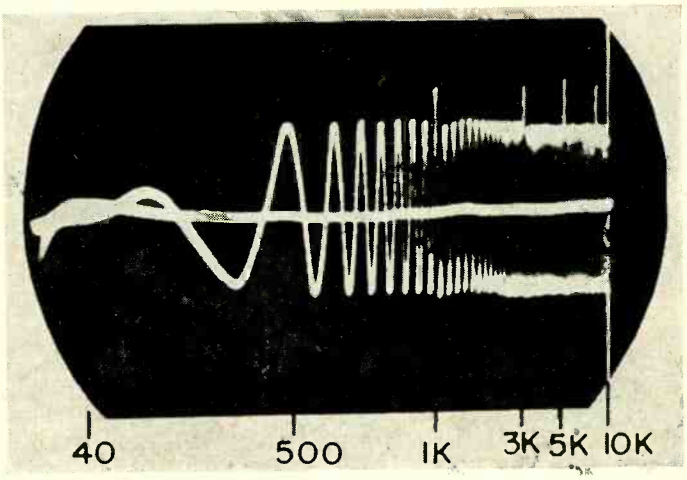


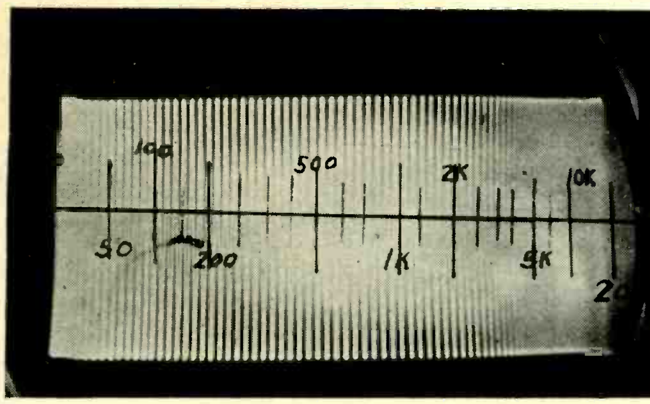
Fig. 1. Photoelectric-Scanner type audio sweep generator signal presentation.

*11 Bayless Ave., Binghamton, N. Y.

1 Electronic-Type Oscillographic Frequency Response Curve Apparatus of Wide Application, W. G. Gordon and A. H. Mutton, *J. Instn. Engrs. Australia*, Feb. 1937

2 Automatic Recording of Audio Frequency Characteristics, *Radio Engineering*, Feb. 1937

3 Audio Frequency Response Curve Tracer, J. B. Sherman, *Proc. I.R.E.*, June 1938



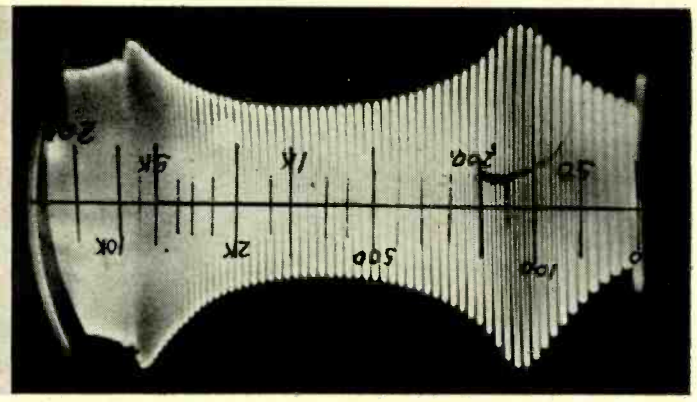
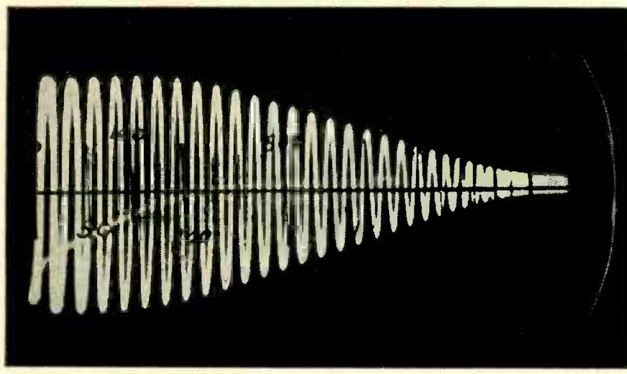


Fig. 2 (left). Output presentation of constant wavelength generator. Note evenly distributed cycle peaks. Level is constant within 1/2 db from 20 cps to 20 kc. Fig. 3 (right). Oscillogram of 20 to 20,000 cps frequency response of UTC Model 3AX Line Equalizer shown in log-log coordinates. The points of maximum equalization were set for 10 db at 100 cps and at 6000 kc.



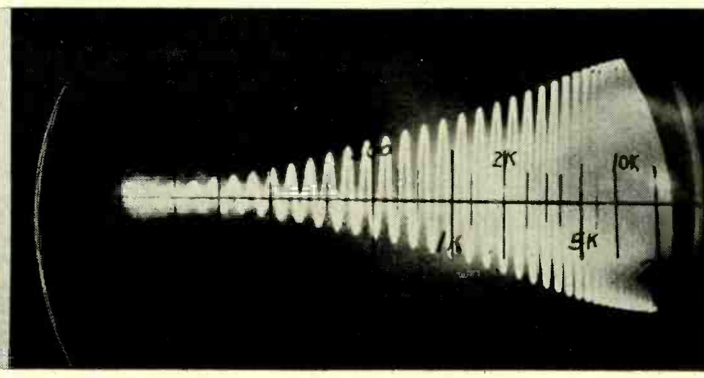


Fig 4 (left). Low-pass single-section RC network shown in log-log coordinates from 20 to 20,000 cps. $R\omega C = 1$ at 250 cps and at 6000 cps. Fig. 5 (right). High-pass single-section RC network shown in log-log coordinates from 20 to 20,000 cps. $R\omega C = 1$ at 8 kc. Note linear 6 db per octave rise.

mately inversely proportional to the log of frequency. It can be readily seen that a much better presentation would result if the wavelength were constant and independent of frequency. *Figure* 2 illustrates this point with an oscillogram taken with the new generator here to be described. The sweep band from 20 to 20,000 cps is shown. Note that the wavelength is approximately constant from 20 to 2000 cps. This feature makes possible the presentation of frequency response curves showing smooth contours in the bass as well as in other regions of the audio spectrum. *Figures* 3, 4, 5, and 6 illustrate various response curves obtained with this new generator.

It is highly desirable to have the frequency response curves plotted in Log vs Log coordinates so that they will closely resemble curves plotted in the conventional manner. That is, the vertical scale should be linear in *decibels* and the horizontal scale should be linear in log of frequency. Since an oscilloscope responds linearly to equal voltage increments and we wish it to respond linearly to equal decibel increments it is necessary to distort the signal applied to the vertical amplifier so that its peak value is always proportional to the logarithm of the output signal from the equipment being tested.

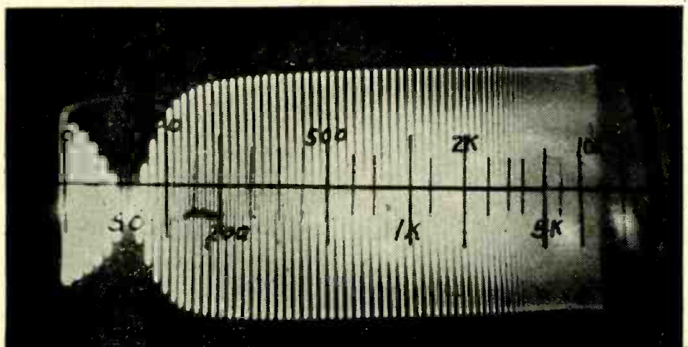


Fig. 6. 50-cps calibration null. Note smooth contours below 100 cps, and sharply defined null.

Generator Design Problems

The design of a suitable audio sweep-frequency generator consists of several problems. Since the constant-wavelength feature depends on maintaining the proper sweep velocity at each frequency on the scale, a suitable sweep-wave shape must be defined and then generated. The frequency must be made to change in synchronism with the sweep voltage and in the proper increments to maintain a logarithmic frequency-scale distribution. Methods for controlling low- and high-frequency band limits must be provided to prevent instability and frequency drift. Frequency markers are necessary for checking the frequency scale. A logarithmic distorting amplifier must be designed for converting the vertical scale to decibels. Each of these problems will be discussed.

It has been seen that the constant-wavelength feature has worthwhile advantages. The following discussion will develop the expression for the sweep direction. A plot of this horizontal deflection as a function of time is shown in *Fig.* 8. On the right edge of this plot is shown a scale of frequencies from which the frequency at any instant can be determined. It will be observed that for 90 per cent of the sweep period the frequency is below 200 cps with the change from 200 to 20,000 cps occurring in the last 10 per cent of the time. It thus becomes evident that a major portion of the sweep time must be spent in the bass register to allow a large number of cycles to occur so that the curves drawn will be smooth in the bass region.

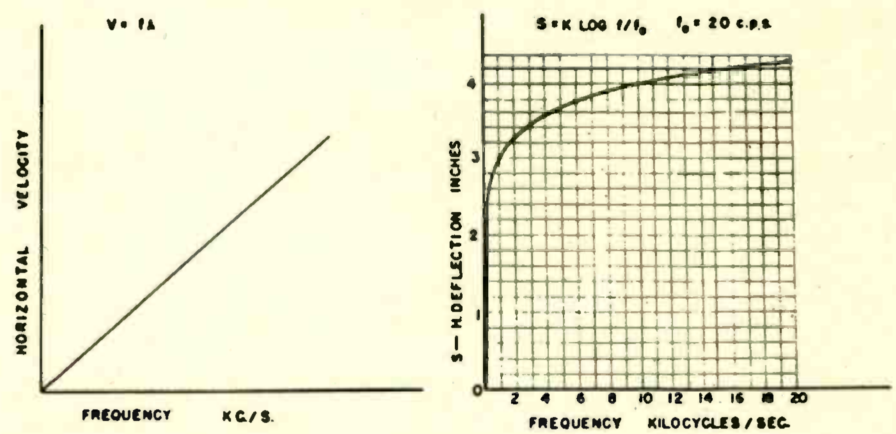


Fig. 7A (left) and 7B (right). Curves of Equations (1) and (2) showing conditions imposed on sweep velocity and frequency-scale division.

Sweep Circuit Details

Needless to say, the electronic circuit that fulfills these conditions did not evolve over night but required trials of many possible combinations before a completely satisfactory system was devised. *Figure* 9 shows the principles of the final circuit, some details being omitted for the sake of clarity. A linear sawtooth wave, generated by the 884 thyratron, is converted to the required wave shape and then drives a remote cutoff reactance tube to frequency modulate one oscillator of a B.F.O. The linear sawtooth wave, $e = at$, is distorted to a wave shape that makes possible this type of presentation. In the case of a wave drawn by a spot moving across an oscilloscope screen while the frequency of vertical motion increases as the spot progresses, a constant wavelength will be maintained only if the horizontal component of the spot velocity increases in proportion to the increase in frequency. This can be stated mathematically as follows:

$$f\lambda = v \qquad (1)$$

where f is the frequency at any point on the horizontal scale, λ is a constant wavelength, and v is the instantaneous horizontal spot velocity at the point. Equation (*1*) is illustrated in the plot of *Fig.* 7A.

The condition of logarithmic horizontal scale distribution can be stated as follows:

$$s = k \log_e f/f_o \qquad (2)$$

where f_o is the initial frequency at the left edge of the screen and s is the distance from f_o to f. k is a constant dependent on total scale length. Equation (*2*) is illustrated in the plot of *Fig.* 7B.

Equations (*1*) and (*2*) can be solved simultaneously to obtain the equation of s as a function of time, since v in equation (*1*) is equal to ds/dt. The resulting equation for a 5-inch scale, 20 to 20,000 cps bands limits is:

$$s = 0.724 \log_e 1 - \left(\frac{1}{.00999t}\right) \qquad (3)$$

where t is expressed in per cent of a sweep period. This expression defines the manner in which the spot must traverse the screen in the horizontal

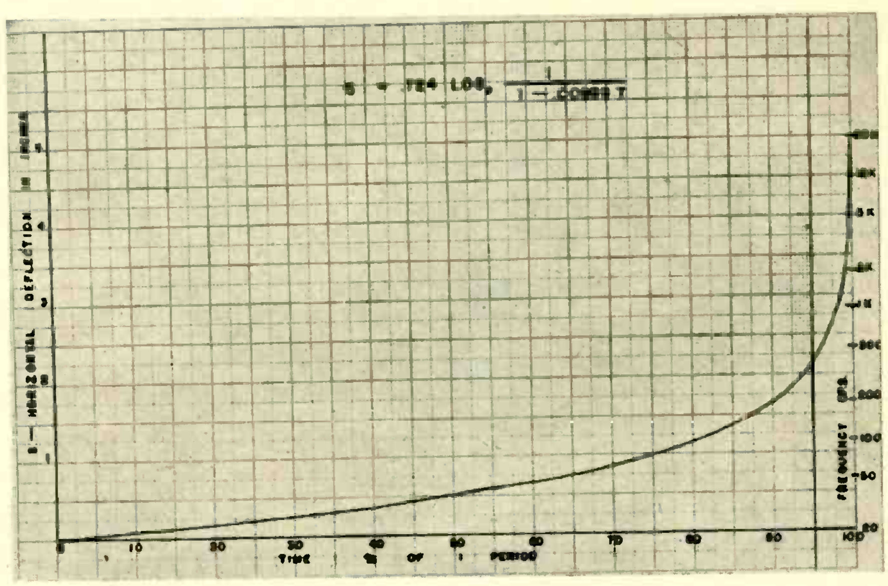


Fig. 8. Required sweep-wave shape plotted in inches horizontal deflection vs. per cent of a sweep period. Frequency scale on right shows required position of each frequency for logarithmic scale.

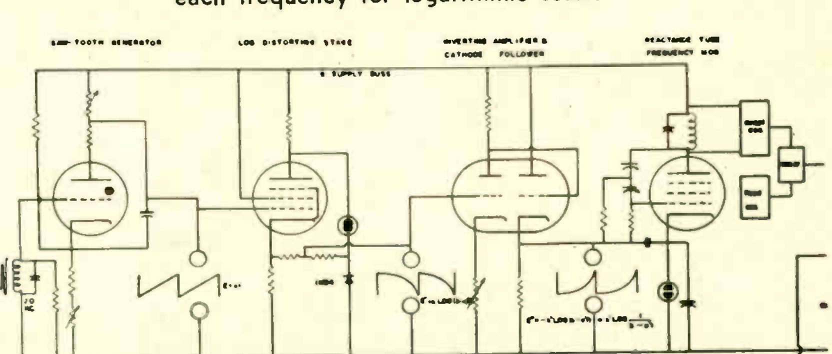


Fig. 9. Simplified circuit diagram of sweep generator, showing wave form at significant points in the circuit.

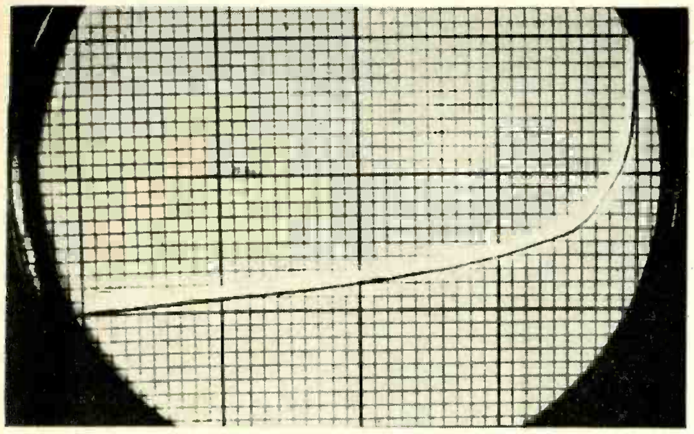


Fig. 10. Oscillogram comparing calculated sweep wave shape with experimentally obtained output from generator of Fig. 9.

log function by means of 1N34 germanium crystals which have the characteristic that the voltage across the contacts is proportional to the logarithm of the current through them[4]. In this case a constant current from the *B* supply passes through the contact rectifiers from which is subtracted the amplified saw tooth wave at the output of the second stage. The wave form at the input to the third stage can therefore be expressed as follows:

$$E' = c \log_e (I_B - I_{saw}) \qquad (4)$$

Where E' is the voltage across the contact rectifiers and c is a constant of proportionality.

The wave form at this point must be inverted to obtain the required sweep voltage since the inversion puts a minus sign before the expression of equation (4) and

$$-\log_e (I_B - I_{saw}) = \log_e 1/(I_B - I_{saw})$$

The output of the amplifier stage, E'', is therefore of the required wave form since I_{saw} is proportional to time and I_B is constant. Thus:

$$E'' = c \log_e 1(b - a't)$$

where c', b, and a' are constants. See *Fig.* 9.

Fig. 10 shows an oscillogram in which E'' is plotted against time and is superimposed on a drawing of the calculated curve. The close agreement between the experimentally generated curve and the theoretical curve is readily apparent.

It will be observed that this waveshape requires great accuracy and stability of the trigger point since approximately half the screen is covered in the last 1 per cent of the sweep period and a very slight jitter in trigger time could easily cause the upper band limit to vary between 20 and 50 or more kc. Stability of the upper band limit is a problem that was solved by causing the trigger time to be determined by the output frequency. Note in *Fig.* 9 that the *LC* network, tuned to 20 kc, in the grid circuit of the 884 is excited in a constant-current fashion from the audio output of the generator. The voltage across this circuit therefore rises as the output frequency approaches 20 kc and triggers the sweep when it is large enough to overcome the bias on the grid of the gas tube. Thus the trigger occurs at the same frequency for each sweep regardless of the total time taken by individual sweep periods. Since the a.c. grid voltage on the 884 increases as the output frequency approaches 20 kc, and ends the sweep when it is large enough to overcome the bias, controlling the bias offers a means of varying the upper band limit. A reduction in bias will lower the voltage required to trigger the sweep and will therefore lower the upper band limit. This control appears on the front panel as the upper band limit control. The upper limit may be set anywhere between 2000 and 20,000 cps.

Control of the lower band limit is achieved by setting the initial bias on the reactance tube grid, thus changing the initial frequency without disturbing the horizontal scale distribution. A decrease in bias merely cuts off the low end of the sweep range and thus raises the lower band limit. A study of the equations reveals that this method of control does not change the constant-wavelength feature except to

[*Continued on page 28*]

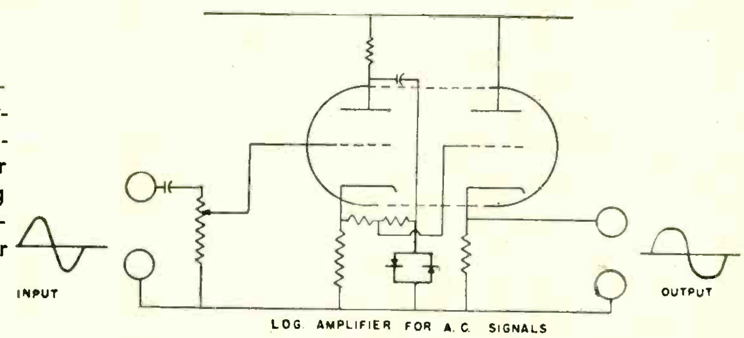


Fig. 11. Circuit of logarithmic distorting amplifier for obtaining vertical deflection linear in decibels.

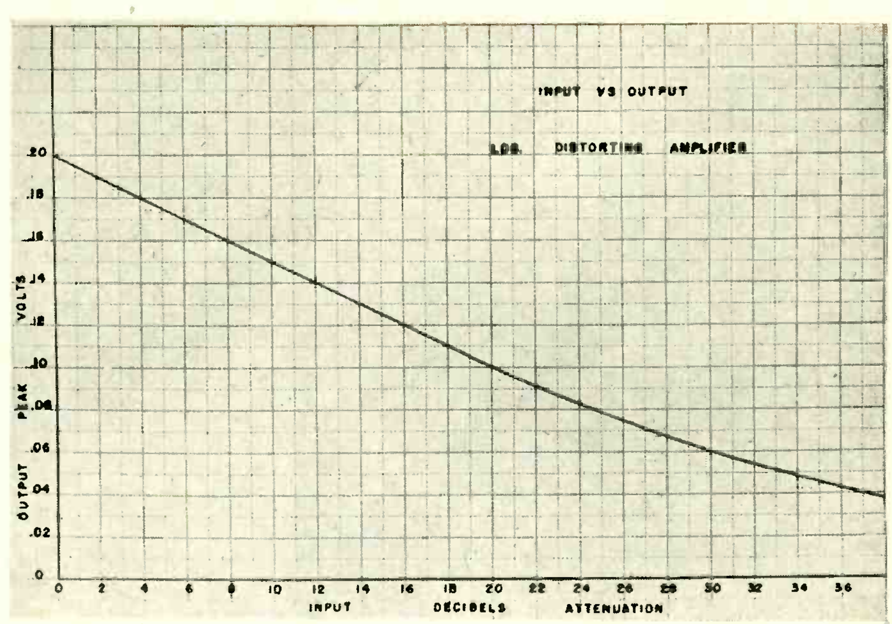
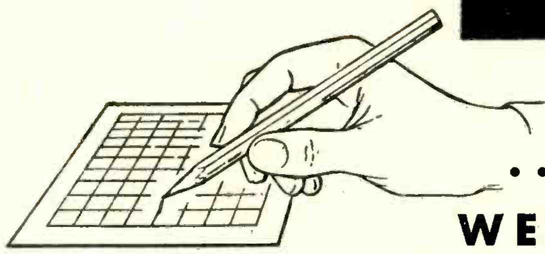


Fig. 12. Input voltage versus output decibels curve for amplifier of Fig. 11 showing linearity of vertical decibel scale.

[4]Audio Frequency Response Curve Tracer, J. H. Jupe, *Telephony*, Aug. 16, 1947

FONO-FITTED TORQUE εν DRIVE **CARTRIDGES**



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With the high compliance and low mass of the driving system, needle forces at 5 grams for both one and three mil records are used in everyday production by leading manufacturers. Cartridges with even lower needle force with slight reduction in voltage are thoroughly practical. 3 gram tracking pressures are definitely in sight.

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One and Three Mil

E-V TORQUE DRIVE again leads in twin needle cartridge design. Tracking force of 5 grams on both one and three mil records precludes weight changing. Straight line needle position assures accurate set down when used with changers. Approximately the same output is obtained on both stylii. The E-V Twin-Tilt cartridge mounts in any arm with ½" mounting holes with no modification except adjustment for correct needle force.

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The cartridge is *entirely filled* with DC4 Silicone jelly—the material that is used for inhibiting moisture on aircraft wiring. Tests indicate that it increases the life of an ordinary crystal *some 20 times.* This is a *plus* feature, found in all E-V crystal cartridges.

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really excellent a-c erase, although it may be only slightly poorer than a typical cheap a-c erase and bias system in which there may be bad wave form and/or d-c components. D-c erasure is, therefore, not to be considered for machines in which maximum quality is necessary; for the cases where it is to be used, the information given above may be of value in design and testing.

The author wishes to thank the management of the Minnesota Mining and Manufacturing Company for permission to publish the data contained in this paper, which was obtained in connection with research on "Scotch" Sound Recording Tape.

MAGNETIC RECORDER

[*from page* 18]

from the tape. Opening the gate of the head housing removes the tape from contact with the heads for fast winding. Threading is extremely simple, as the tape can be merely dropped between the open gate and housing with no fear of snarling or catching. Tilt adjustments are provided on the record and playback heads so that they may be aligned while the machine is running.

Amplifier Assembly

A great deal of work has gone into the simplification of all electronic components to reduce size and cost. Wherever possible, costly transformers have been eliminated, and dual tubes such as the 6SN7 have been used to reduce space requirements.

The recording amplifier has a bridging-input transformer, which can be used either matching or bridging, and the amplifier has sufficient gain to record from any line level from —30 VU up. Ample recording current is provided so that no distortion is introduced by the recording amplifier well beyond the current necessary to saturate the tape. A screwdriver gain control is provided, as well as a high-frequency equalizing adjustment and a bias current adjustment.

A novel bias and erase supply has been provided which leaves the tape remarkably quiet, and which is uncritical to voltage variations and other adjustments.

The playback amplifier will deliver + 25 dbm at 1 per cent total harmonic distortion into a 150- or 600-ohm line. This is ample reserve for the normal operating level of + 4 VU to + 8 VU. A screwdriver gain control is provided, and a high-frequency equalizing adjustment for flat playback response from a standard tape.

Overall performance characteristics are well within the proposed NAB standards. Frequency response is ± 2 db from 50 to 15,000 cps at 15 inches per second, and ± 2 db from 50 to 7500 cps at 7.5 inches per second. The signal-to-noise ratio is better than 60 db measured in accordance with the NAB definition (ratio of peak recording level to total unweighted noise level recording zero signal; peak recording level is that point at which the overall total harmonic distortion does not exceed 3 per cent measured on a 400 cps tone).

At the 15-inch speed, flutter and wow are well below 0.1 per cent. This measurement is made on a bridge which measures all flutter components from zero to 300 cycles, using a signal of 3000 cycles. At 7.5 inches, the flutter and wow are less than 0.2 per cent.

The final test of performance is in listening. The most critical test that can be made is the "A-B" test, whereby the output of the recorder is compared with the input by rapidly switching the monitoring equipment between input and output. Because of the minutely detailed comparison which can be made at the time of switchover, slight discrepancies between two systems can be detected by means of the A-B test which would never be noticed if the systems were listened to separately. When making critical A-B tests on the Model 300, using live program material of the most exacting nature, and with the highest quality amplifier and speaker systems, it is impossible to distinguish recorded material from the live program.

PROBLEMS IN AUDIO

[*from page* 20]

by the velocity of the sound. This gives the expression $I = c\,E$ or $2\pi^2\rho_s{}^2c^3a^2/\lambda^2$ or $I = 2\pi^2\rho_s{}^2c\,f^2a^2$ ergs/sec/cm².

In all of the above equations the units have been given in the metric system, which is the standard system of units. However, since many authors still use other systems, Table I gives the relation of metric units to the others, and Table II lists the reference values of physical constants. It is important to remember that the constants of the medium change with temperature and it is therefore necessary to use the appropriate values for the temperature at which the computation is to be made. The values given here are for room temperature, 20° C. being equal to 68° F., which is close to the normal working temperature of most places in which audio work is carried out and for which calculations are of importance. In the following articles, consideration will be given to generators and sources, and to applications of the material in this article.

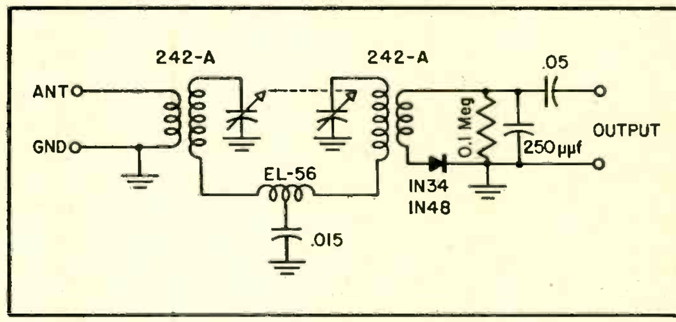
Techni-Briefs

TUBELESS "HI-FI" TUNER

High-fidelity addicts will remember the Western Electric 10A Radio Receiver as, for its time, one of the best from the standpoint of quality but it was not commercially available to the home user. The circuit of this tuner was simplified and appeared on the market as a wide range unit, employing a four-gang capacitor and a total of eight coils (two of them untuned) and three or four tubes. Having a wide pass band, it was useful only in close proximity to radio stations, and the sensitivity was not very great for this reason. However, the audio quality was excellent, and there are many of these wide-range tuners still in use.

Utilizing the same circuit principles, a new tuner has recently appeared which serves practically the same purpose. It is broad, and thus suffers from no side-band cutting; it has low sensitivity, which is desirable for tuners of this type; and it has remarkable audio quality. The circuit of the tuner is shown in *Fig.* 1, and it will be seen to consist of two antenna coils essentially back-to-back, with a two-gang tuning capacitor and a negative-mutual coupling coil (EL-56 on the schematic). The 1N34 Germanium diode serves as the detector, with the signal being developed across the resistor.

Fig. 1.



This tuner is designed for use in metropolitan areas where there are likely to be a number of radio stations within a radius of 20 to 25 miles, and when used with a good antenna from 75 to 100 feet in length will give an audio output ranging from .05 to 0.5 volts. Even with a shorter antenna, satisfactory results are obtained with an output of less than .001 volts, providing the signal is fed into a high-impedance microphone input channel of a high-quality amplifier.

The coils specified for this tuner are the products of J. W. Miller Co. of Los Angeles, and while a complete kit is available—consisting of the coils, tuning capacitor, slide-rule dial, and chassis—it is possible to assemble the tuner with any desired chassis and capacitor, provided it covers the tuning range. For satisfactory results, it is necessary that high-Q coils be employed, and this requirement is fulfilled by the 242-A coils specified.

CATHODE FOLLOWERS

[*from page* 13]

has a data book transconductance of 9000 micromhos, and a mu of the order of 5000. With resistance coupling and reduced plate voltage we lose, but probably can still realize a transconductance of 5000. With a little computing we find promise of an output/input ratio of .98 to .99, and an output impedance of about 200 ohms.

Some Practical Matters

We are now ready to consider the design of the actual circuit, and its execution in a reasonably dependable assembly.

First, we must apply d.c. to the heater of the 6AC7. In spite of anything written to the contrary, a cathode follower with a.c. on the tube heater is full of hum. Rectified a.c. is permissible if the filtering is adequate, and if the heater is kept at ground potential to a.c. To avoid injuring the heater-to-cathode insulation we are then compelled to use a voltage divider and capacitor arrangement, with the heater at cathode potential for d.c. and at ground potential for a.c.

The plate supply voltage must be well filtered. Some papers have claimed that plate supply ripple is degenerated out in a cathode follower, and that poor power supply is permissible. Practical experience does not bear this out.

In laying out the input circuit, make it as short as possible. If you have too much stray capacitance, it can be guarded out by a shield driven by the cathode, but good design will shorten the leads to a point where no guarding is necessary. Such driven shields are undesirable, because their capacitance to ground acts as an additional capacitive load on the follower output.

This brings us to the circuit itself. In its design, remember that the output will always be loaded with at least 100 $\mu\mu$f of input cable and plug capacitance. If a shielded output cable is to be used, allow another 100 to 150 $\mu\mu$f. Do not assume that the low internal output impedance of 200 ohms will make the follower immune to such loading, for it will not.

A representative circuit is shown in *Fig.* 6. Its input impedance with three feet of the cable previously discussed is 100 megohms and 6 $\mu\mu$f. Performance curves are shown in *Fig.* 7. It is interesting to note that the output/input ratio is invariable up to a few volts below overload. In this connection it is significant to observe that when the ratio is of the order of 0.98 and 0.99 the distortion is too low to measure with ease. High quality oscillators are apt to have a harmonic distortion of 0.1 or 0.2 per cent which is of the same order as that which we are trying to measure. When the output/input ratio decreases, distortion begins to be significant. *Figure* 8 shows that in the design given the ratio has remained virtually constant up to the point at which the distortion begins to increase rapidly.

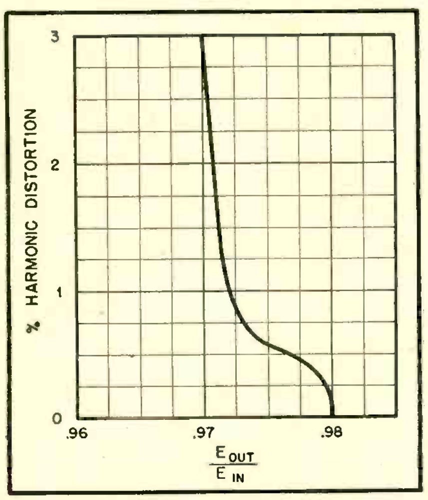


Fig. 8. Harmonic distortion vs. voltage ratio of cathode follower.

In connection with measurement of very low distortion values, it is necessary to remember that a copper oxide voltmeter will generate distortion in the circuit to which it is connected, and that this distortion will be negligible only when the meter resistance is quite high compared to the circuit resistance. Otherwise, as much as 0.5 per cent distortion has been observed.

Higher Voltage Rating

A glance at *Fig.* 7 shows that the particular design illustrated in *Fig.* 6 is limited to input voltages of the order of 35 volts maximum. It is possible to make special designs for higher input voltages, by various obvious means. In most cases, however, it is preferable to insert a voltage divider at the input to the cable.

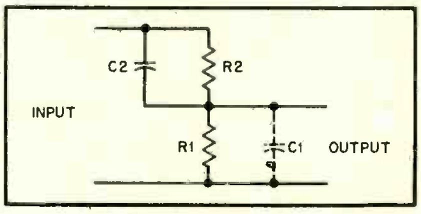


Fig. 9. Voltage divider circuit.

In this circuit the voltage ratio at low frequencies is set by the resistance ratio. At higher frequencies the cable capacitance C_1 begins to change the accuracy of ratio. A small capacitor C_2 is therefore added across R_2, and is adjusted to keep the ratio correct at higher frequencies.

The circuit which has been described promises to improve both convenience and accuracy of measurement in the audio laboratory by making it possible to bridge instruments across any part of a circuit with impunity.

RECORD REVUE

[*from page* 21]

province to suggest that these LP troubles are inherent in the system itself—maybe not. Still, my impression is that such difficulties should be less in the 45 than the wide-expanse LP recording. My feeling is, too, that whatever the reason, I will expect to find more uniformity between standard and 45-rpm versions of a recording than between standard and LP—the LP often differing markedly in one way or another from the standard. This impression may change with time.

After LP playing, the return to a changer has been unpleasant. I find the small records more clumsy in the unpacking, sorting, setting up and repacking than the standard records which lift easily out of their folders in an album. The changer is on the average slower at the breaks than my standard changer with its valuable velocity trip feature. The lack of a shut-off at the last record has fooled me time and again, when attention wandered a bit, into letting the top record repeat several times; one must keep constant mental count of the sides played in order to catch the machine before it begins that fatal repeat and this only accentuates the annoyance one feels at the same old musical breaks. (Again, this is the classical record collector, the minority, speaking!) I have considerable trouble with the arm bouncing as it lands, amputating the opening passage. Even with brand new records I have already run into slippage and have seen a record stop entirely and refuse to turn at all. But note, these are minor troubles, annoying in present equipment but not impossible of correction—though why RCA didn't figure on a corrugated ring to lock the records together I can't for the life of me see. A better center-operating changer would be simple enough, though perhaps more costly; it should decidedly have an automatic stop after the final record and a gentler arm movement, whatever the cost. RCA should be able to lick the serious problems of warpage and slipping without too much difficulty. Beyond this, I don't see that complaints are easily made, except those that are irrelevant, such as those concerning the original recording. Ah yes—one more thought: the RCA records are at such a low level that plenty of gain is needed, often considerably more than with the LP record and thus all sorts of minor technical deficiencies are apt to be shown up in the input end of many outfits. True, ghosts and the like are avoided and the records may well play longer and easier. But is the sound better? Surface, too, rears its ugly . . . well, surface is a danger anyway.

And so we get back to the basic division between standard-play and long-play record and to one more—the matter of available repertory. Here there seems to be little more than pure policy decision. Columbia has delved widely and extensively into its past library to bring out enormous numbers of older recordings in LP form, covering every taste. RCA Victor, on the other hand, has made a preliminary catalogue mostly from popular classical favorites, best sellers, and has added only a tiny dribble of recent records to that catalogue since then. Why, is anyone's guess. Perhaps the older RCA records aren't up to the Columbias on 16-inch? If Capitol can dub the Telefunkens of years ago onto 45, surely RCA can find something in its catalogue to haul out? Apparently the policy has been set to issue new recordings only on 45. If so, I opine that such a policy is a mistake. On the other hand, it is quite true that the attraction of the RCA reissues is less than that of the LP's, since the advantages are confined to the size and convenience of the new record, with little other than improved surface noise in the actual sound. Same old breaks. The LP no-breaks advantage is, no getting around it, a sales point of the first magnitude not to be matched by the no-distortion argument—or so it seems to be, as I see it.

How long can all this last? Years, perhaps. But my own strictly private feeling is that there will have to be a deal, and that deal not so terribly far off, what with some rumored additions to bandwagons coming up. Meanwhile I shall continue to enjoy both 45's and 33's for what's on them —and that's a lot. I like music!

(May I remind readers that the viewpoints expressed above are strictly my own and in no way necessarily represent the attitude of the magazine itself or any of its officers. This is inserted at my own suggestion, not the editor's. E.T.C.)

Recent Recordings

Prokofieff, Scythian Suite (1914)
Philadelphia Orch. Ormandy.
Columbia LP: ML 4142(½) MM 827 (3)

● This is not quite the type of music ordinarily to be found on the month's best demonstration record, but once you've listened you'll see why it's bound to take a high prize. The music itself is far more complex but not outwardly so very different from the well-known Gayne suites of Khatchaturian (who, writing a quarter century later, was merely stealing somebody else's thunder). It is savage, primitive sounding music, full of fine thumpings and poundings in the bass and with brass and percussion galore in the upper ranges. Columbia has recorded it with these facilities placed well to the front—or so it sounds—and the result is a most gratifying bedlam sharp and clear! I haven't heard the standard version; the LP is terrific. (The Respighi Roman Festivals on the reverse, released on standard some time back, has some pretty good sounds in it too.) If you are curious as to how-come Prokofieff was caught writing stuff like this, remember that at about the time of the first war there was a great rash of this kind of primitivism, in other arts as well as music, and almost every composer fell in line at least for a time. The "Sacre de Printemps" (Rites of Spring) of Stravinsky was the leading noise maker and is decidedly the best known example now; but even Stravinsky wrote others in the style—"Les Noces," for example. Prokofieff wrote a group of "barbaric" works, including the often-heard first violin concerto; but the pagan rite was not really his line and he left paganism for the more suave and polished music that we hear ordinarily from him. It is interesting that the well-known "Classical" symphony was written at about the same time as this utterly different music.

Gould, Spirituals for Orchestra.
New York Philharmonic, Rodzinski.
Columbia LP: ML 2042(½) MM 832 (3)

● This is no doubt a good many months old, since Rodzinski left New York a season ago but it rates with anything new so far available. The music—"classical", technically speaking—is the sort we have heard before from Gould, hard, dissonant, perhaps even embittered, avoiding a bit too carefully the pat and slinky harmonies of the popular-style Gould; one movement, inevitably, breaks down into a highly jazzy bit of humor and this may be the best of all, it being the most natural. Because of the colorfully dry orchestration (Gould is a master of that) this makes for a good demonstration record though the severity of the music perhaps will dampen the engineer's ardor. I have the standard version; the LP includes the word-and-music "Lincoln Portrait" of Aaron Copland on the reverse.

Mozart, Serenade #10 for 13 wind instruments, K. 361.
RCA Victor DM, WDM 1303 (4)

Bach, Suites #1 in C, #4 in D.
Boston Symphony Orch. Koussevitsky
RCA Victor DM, WDM 1307 (5)

● Results from the various recording sessions at Tanglewood, where the Berkshire Festival occurs with this orchestra each summer, have been curiously uneven. Some Tanglewood records have been by most critical accounts atrocious—the Beethoven Ninth Symphony for instance. Others, the above included, have turned out remarkably well. Probably due to different recording locations but in any case the Mozart and Bach items here which I have in the 45-rpm version, give forth an excellently sonorous sound, spacious, with good sense of depth and perspective not to mention a modest but comely expanse of good highs. The Mozart succeeds an earlier RCA version (which RCA apparently forgot it owned—the publicity named this new one as the first in the RCA catalogue!) by Edwin Fischer, made 'way back, in Europe and sounding musically very much like this though omitting some of the music here recorded (V 743). There is a new European version I haven't heard, said by some to be better; I find the RCA new one a thoroughly adequate, straightforward rendering by a group of excellent musicians and would not be inclined to demand anything better. The music is the sort of gay outdoor type much favored in Mozart's day—it was the ancestor of the "German band"—but this is on a far meatier level (to make a strange metaphor) than most such serenade music and indeed is one of my favorite Mozarts. The long slow introduction to the first movement is the high point. The Bach suites come forth from the Koussevitsky factory a good deal better made than the Brandenburg Concertos also recorded at Tanglewood. Except for some dreadful slowings-down at the ends of movements, quite unwarranted, the playing here is straightforward and accurate and the Baroque splendor of the music comes through most effectively in the big, live RCA recording. Incidentally, the Bach album contains some of the most painful musical breaks, at the ends of the sides, I have yet to hear, rather unfortunate considering the present delicate situation, LP vs 45!

A good test of 45-rpm at its best by the way, is the reissue of Stokowsky's already well known Tchaikowsky "Sleeping Beauty" ballet music, WDM 1205. Quality-wise, you won't find much to complain of here. Watch out for a faint low-pitch hum (60 cps?) which I seem to detect in some of the 45's. Picked up at some stage in the dubbing?

Mendelssohn, Symphony #3 ("Scotch")
Chicago Symphony, Rodzinski.
RCA Victor DM 1285 (4)

• Here we catch up to the rapidly moving Rodzinski during his Chicago stay—he's left there by now. There's nothing in this that will make your Scotch blood tingle if you have any—it was this symphony that sent the slightly absent-minded Schumann into rhapsodies over its wonderful *Italian* atmosphere (he had accidentally mixed it up with number 4, the "Italian" Symphony); Scotch or not, you'll find it the best in easy expressive tuneful Mendelssohn, a well made and thoroughly pleasurable symphony, if not overly profound. The Rodzinski performance seems to me excellent and the RCA recording is good too, with acoustics perfectly suited to the music.

Scriabin, Poeme d'Extase
San Franscisco Symphony, Monteux.
RCA Victor SM 1270 (2)

• If you like near-hysterical music, you'll like this (but some people call Wagner's "Tristan" hysterical; maybe you'd better judge for yourself!). You may ignore the complicated mysticism which is the Scriabin hall-mark; musically it doesn't matter much though historians may make much over his ideas, as he certainly did himself. What's interesting here is the similarity in the acid harmonies of this 1909 music to much of the early Stravinsky of shortly later—Stravinsky being, as far as anyone can say, the ultimate example of the hard-headed realist in music. This music is the kind of "ecstasy" that never lets down from beginning to end; its tautness fascinates some, bores others. Its performance by Monteux is a guarantee of the best; Monteux, the great French conductor has made his San Franscisco Orchestra into one of the world's leading exponents of French orchestral music. Strange things happen in California!

Schumann, Manfred Overture; Beethoven, Consecration of the House Overture.
NBC Symphony, Toscanini.
RCA Victor DM, WDM 1287 (3)

● If you have a yen for something by Toscanini, pass up the Tchaikowsky 6th symphony and try this. To my ear at least this is about his best album with the NBC to date. Both overtures benefit from the well known Toscanini drive, since both—each in its own way—are a bit heavy handed. Toscanini makes 'em get up and go and the real stuff in both comes through superbly. Moreover, again to my ear, the recording itself is better, more natural with better highs and bigger liveness than the Tchaikowsky 6th recording. Don't ask why. (See last month for review of the Tchaikowsky, WDM 1281 and DV 27.)

For those who haven't caught on yet . . . the "W" records from RCA Victor, with same numbers for the albums as the standard, are 45 rpm issues. Single 45's, alas, have entirely different numbers from their 78 counterparts. Columbia LP's are renumbered, with 12-inch records in the 4000 series and ten-inch in the 2000. Columbia slow speed singles, 7-inch, also have different numbers from the 78 counterparts.

Beethoven, Violin Sonata #1 in D, opus 12; Schubert, Violin Sonata #1 in D, opus 137.
Joseph Szigeti, violin, with V. Horzowski, Andor Foldes.
Columbia LP: ML 4133

● A new recording and a quite old one of two sonatas which coincidentally have the same numbers and keys. The old one is the Schubert, a well known recording in its original shellac pressing; it is one of those improved LP reissues, going back to re-dub the original 16-inch master (though there seems to be some wavering in pitch that shouldn't be present). The new one is the Beethoven, and the comparison is quite interesting: the new recording is far sharper in the highs than the old, though both have adequate tonal range—it is as though the characteristics to 10,000 were radically different in the two. The new one has considerable preemphasis the old has relatively little, if any. Just how this comes about I do not know, but that is indubitably the effect, and other new-old LP couplings show similar contrasts. With equalization by ear, one can get the two to sound very much alike. Interesting that in the new Beethoven recording Szigeti exhibits a walloping wobble that is entirely absent in the old Schubert, of eight or ten years ago. Does he realize it himself, I wonder? Both are excellent performances of genuinely listenable music—if, again, you can take violin and piano. Of the two, the Schubert is the most catchy for the inexperienced ear—like so much Schubert, it grows on you fabulously once the tunes are embedded. (Neither of these recordings is up to the Decca ones reviewed above, good as they are. Note that in the Beethoven, Szigeti can again be heard breathing, so close is the mike, so wide the tonal range!)

Haydn, The Musical Clocks.
E. Power Biggs, organist
RCA Victor 49-0419 (7") 10-1471 (12")

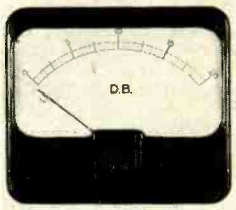
● These compete for the Shortest Pieces Ever Written—they were designed for the musical clocks that were the scientific marvels (and true ones, too) of the 18th century. Biggs plays them on clock-like stops in the organ. There are eight of them on one record. It's real music, too.

PROFESSIONAL DIRECTORY

NEW PRODUCTS

• **"Broadcast Station Measurements"** is the title of 38-page booklet offered by Hewlett-Packard Company, 395 Page Mill Road, Palo Alto, Calif., free to all radio station chief engineers. It gives full information on making measurements required by amendment (e) to Section 3.46 of "Standards of Good Engineering Practice." This "how-to-do-it" manual states the requirements for both AM and FM broadcasters, lists the equipment necessary to make the measurements, and gives detailed procedures for measuring, recording, and tabulating the information in a manner which will be acceptable to the F.C.C. Included in this company's line are most of the test instruments necessary for making the required measurements.

• **The Model 140 Disc-Noise** Meter is the first commercially available device for checking noise level of lacquer discs and test pressings. Disc Recording companies have long needed some method for making these measurements, and improvised arrangements often resulted in inaccuracy and



in damaged meters. The unit consists of a high-gain preamplifier, a new logarithmic circuit, and a v-t voltmeter so arranged that the indicating instrument is overload proof. The logarithmic circuit permits the use of a linear db scale, covering a range of 20 db, and the instrument itself has the same ballistic characteristics as the standard VU meter. Information: Audio Instrument Co., 1947 Broadway, New York 25, N. Y.

• **Simplex Tape Splicer** is the logical answer to the requirement for a low priced unit for making a splice in magnetic tape quickly and easily. Uses a non-magnetic block to avoid degradation of the recorded

material during the splicing operation and accurate machining ensures a straight, true joint which is stronger than the tape itself. The unit is available from Burnett Service Co., 178 W. 168th St., New York 52, N. Y.

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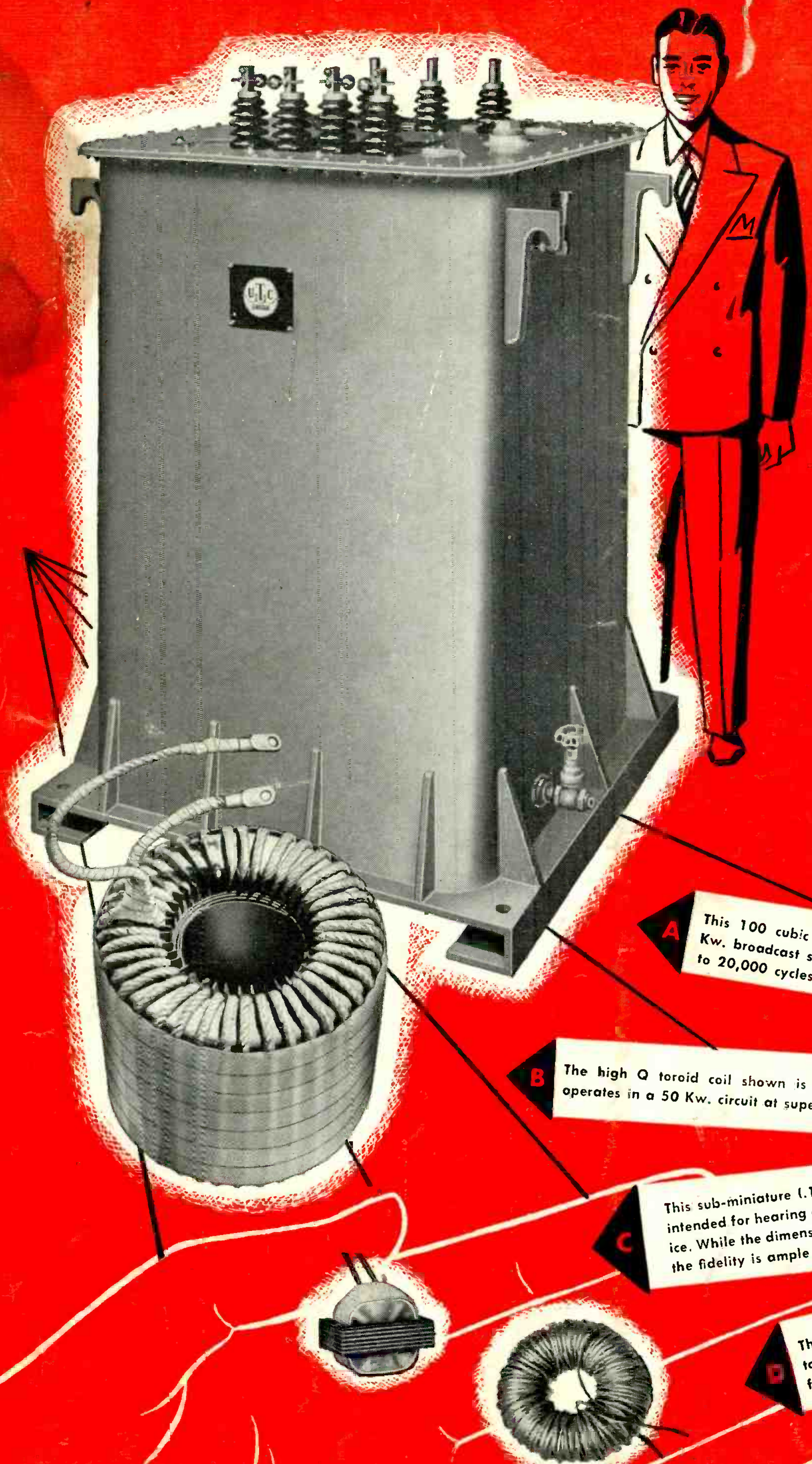

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