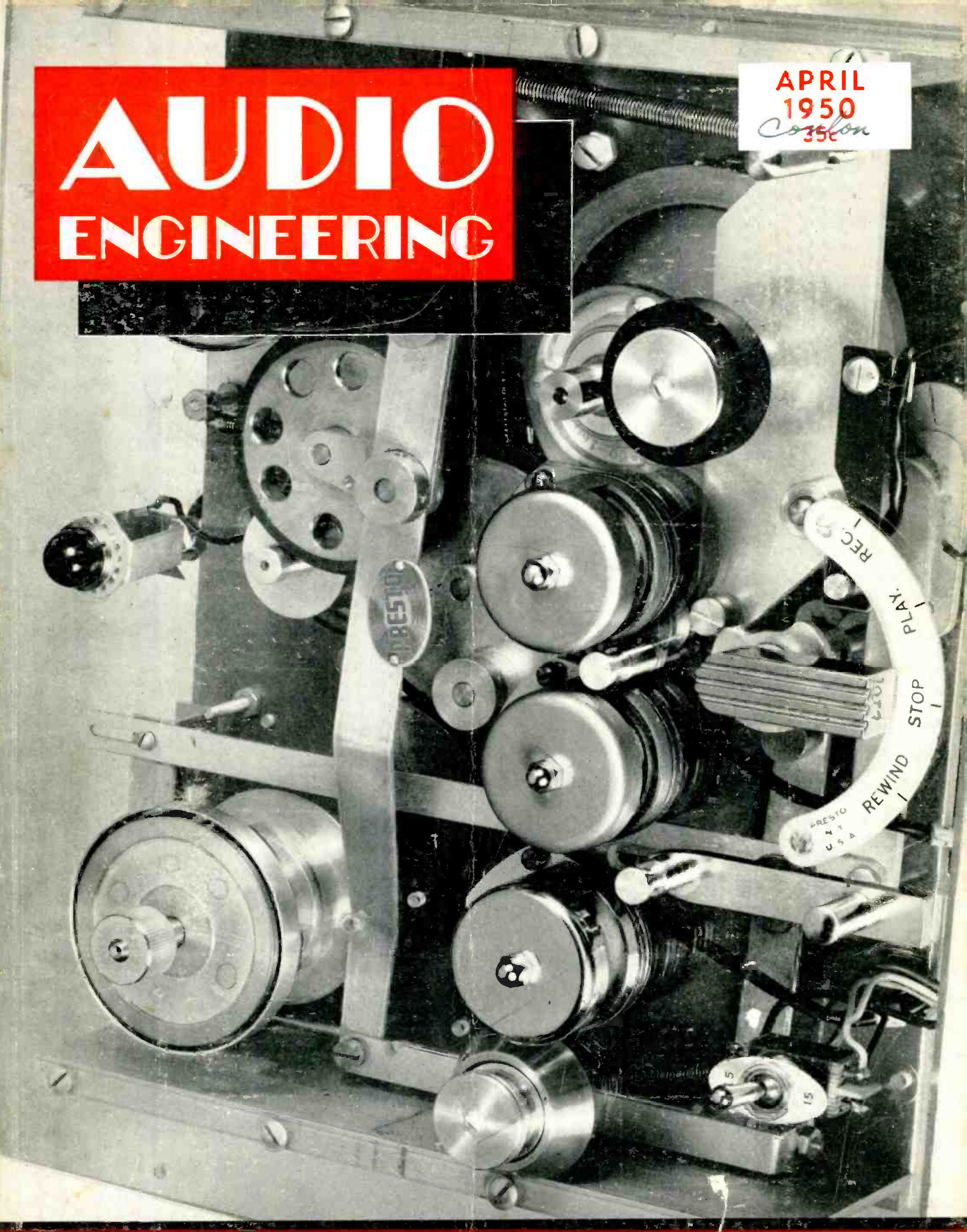
AUDIO ENGINEERING

APRIL 1950
35¢



HERE'S WHAT THEY SAY ABOUT audiotape*

From all parts of the country—from users in every branch of the recording art—hundreds of reports have come in, commenting on the performance of Audiotape. The typical comments quoted below speak for themselves.

If you haven't tried Audiotape yet, why not see for yourself just what it can do to improve the quality of your tape recordings? Your local Audiotape and Audiodisc dealer will be glad to fill your requirements. Or, write to Audio Devices for a free 200-foot sample reel of either paper or plastic base Audiotape. It will speak for itself.

A Recording Service

"We find that your plastic Audiotape meets our requirements far better than the others we were using. We were bothered with flutter before, but now it seems that our discs we duplicate from tape are of much better tonal quality."

A Sound Consultant

"I have tested the samples on several recorders under various conditions. Both paper and plastic base proved to be as fine as any I have yet used--good frequency range and especially low noise level (inherent)."

A Radio Station

"We find Audiotape to be the best so far obtainable. There is less dust, dirt, and grit accumulation from this tape compared to others--as a result our machine runs at more constant speed."

A University

"We are using No. 1251 to record sound tracks for our educational films. We find the product very satisfactory and particularly appreciate the flat tape that does not hump away from the head in the middle."

A Research Laboratory

"Have found your tape the best for my recorder. Very low noise level and very uniform characteristics are its outstanding qualities. Price is also attractive."

A Home Recordist

"We've compared Audiotape with the tape we've been using and were impressed with the fidelity and low noise level. The output for a constant level 1000 cycle input is remarkably good, showing uniform coating."

A Broadcasting School

"I am happy to report that of several brands of tape tried, Audiotape has the lowest consistent noise level. Over-all response is remarkably consistent for all parts of each reel."

An Industrial Firm

"I find that this tape excels all other makes now on the market in quietness, range, and ease of handling. On the strength of the test sample, have disposed of all other makes and am now using only Audiotape."

A Grammar School

"We have used various tapes in our school work here and really know that yours is second to none. You can expect an order from us shortly."

A Radio Station

"We are very pleased with your Audiotape samples. Noise level very low and quality excellent. We use it whenever a good reproduction is desired. We find your tape and your discs best in the field."

A University

"We are delighted with the plastic base sample and in the future plan to order it exclusively. In speech work fidelity is very important, and we feel that the plastic Audiotape is the best we have tried."

A Radio Station

"Results from tapes tested--excellent. Low noise levels --low distortion. Seems to be less capstan slippage than other tapes. Attractive prices. All future purchases by us will include Audiotape."

A College

"Thanks for the Audiotape samples. We are using your plastic base tape exclusively for the original recording of our radio programs. We find that there is practically no loss dubbing from tape to discs."

A Radio Station

"Excellent tape -- much less flutter due to its ability to fit head contours better. All of our new tapes w'll be Audiotapes."

* Trade Mark

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Type No.	Primary matches following typical tubes	Primary Impedance	Secondary Impedance	± ½db from	Maximum level
F1950	Push pull 2A3's, 6A5G8s, 300A's, 275A's, 6A3's, 6L6's.	5000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1951	Push pull 2A3's, 6A5G8s, 301A's, 275A's, 6A3's, 6L6's.	5000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1954	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1955	Push pull 245, 250, 6V6, 42 or 2A5 A prime	8000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1958	Push pull 6B5, 6A6, 53, 6F6, 59 79 89, 6V6, Class B 46, 59	10,000 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	15 watts
F1959	Push pull 6B5, 6A6, 53, 6F6, 59 79 89, 6V6, Class B 46, 59	10,000 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	15 watts
F1962	Push pull parallel 2A3's, 6A5G's 300A's, 6A3's, 6L6	2500 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	36 watts
F1963	Push pull parallel 2A3's, 6A5G's 300A's, 6A3's, 6L6	2500 ohms	30, 20, 15, 10; 7.5, 5, 2.5, 1.2	20-30000 cycles	36 watts
F1966	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	500, 333, 250, 200, 125, 50	20-30000 cycles	50 watts
F1967	Push pull 6L6 or Push pull parallel 6L6	3800 ohms	30, 20, 15, 10, 7.5, 5, 2.5, 1.2	20-30000 cycles	50 watts

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APRIL, 1950 Vol. 34, No. 4

COVER

Phantom view of the now well-known Presto PT-900 tape recorder mechanical unit, photographed with a lucite panel so that all of the internal workings may be seen clearly. This machine was the first to incorporate a three-head design into a portable unit capable of broadcast quality.

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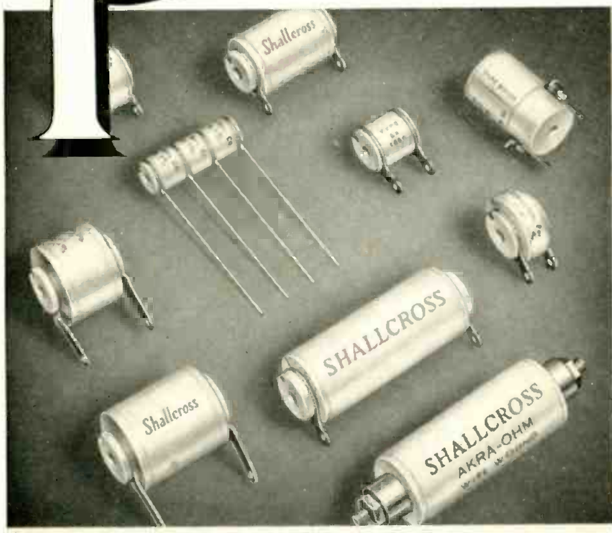

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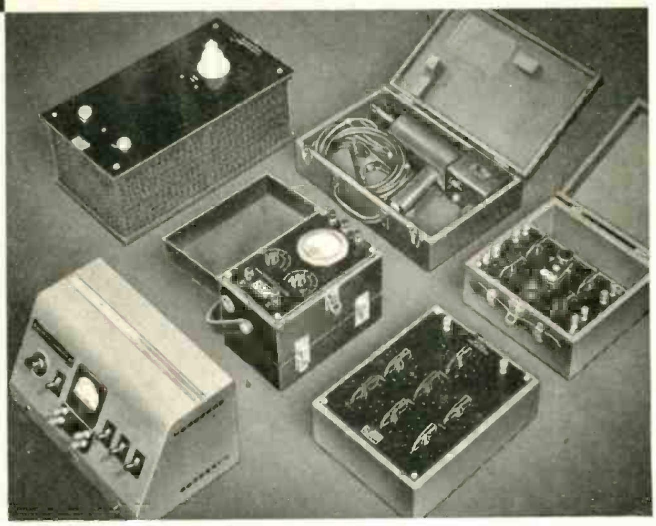

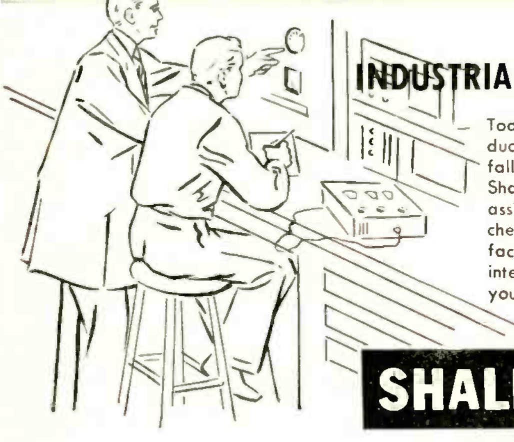

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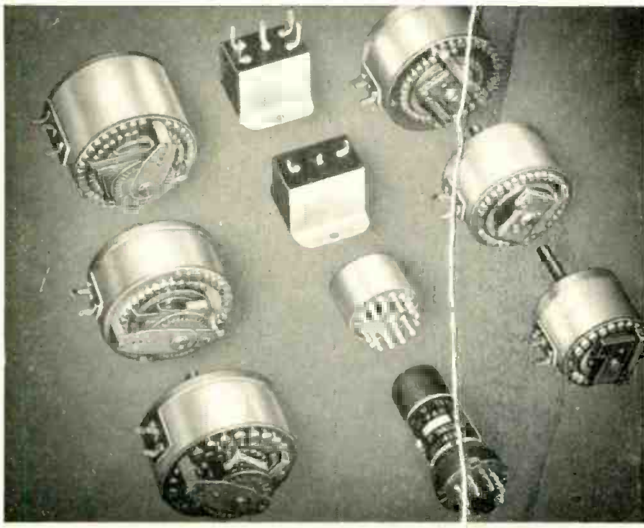

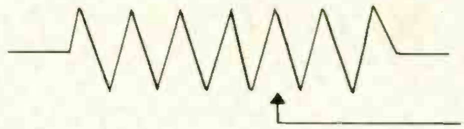

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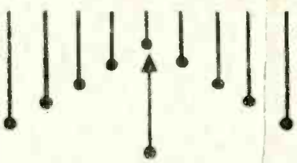

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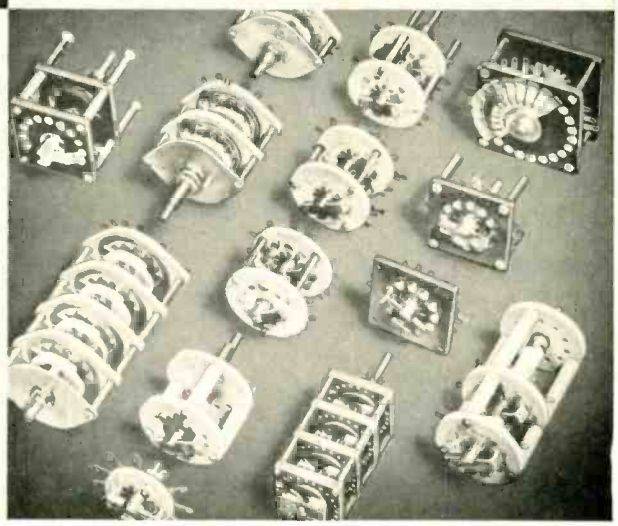

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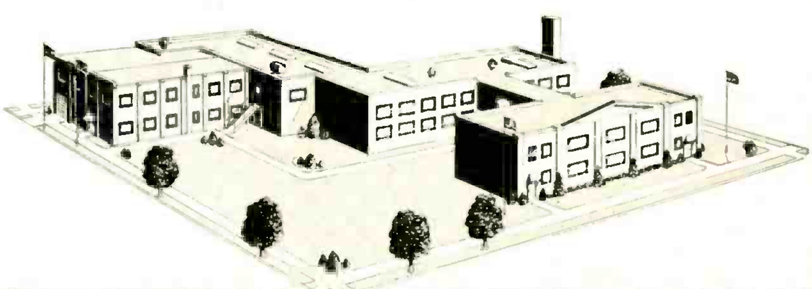


COMPANY Dept. A-40 **Collingdale, Pennsylvania**

LETTERS

The Other Side

Sir:

We are not unduly sensitive to informed criticism. In his article "Audio in England" in your January issue however, Mr. Hartley appears to us to be indulging in a private war of his own and goes beyond the limit of fair comment, and we hope we may be allowed to occupy a little of your space in reply. Admittedly he does not mention us by name but as we are the company manufacturing the Klipschorn speaker in this country he might just as well have done so.

For many years we have been convinced that the most promising way in the development of high quality reproduction lies in multi-channel loudspeakers and have manufactured instruments of this type since well before the war. The main difficulty, of course, has been to obtain adequate low-frequency response at reasonable efficiency without introducing resonance and, at the same time, to keep the overall size of the instrument small enough to be used in an average living room. When the specification of the Klipschorn model appeared in the American technical press it appealed to us as an ingenious solution to the problem and we obtained permission from Mr. Klipsch to make an instrument incorporating his principles using, of course, our own high- and low-frequency units. We do not pretend that this is everyone's speaker—size and price (£135.0.0d, not £200.0.0d) prevent that—but as a well designed instrument based on sound logical principles it seems to us to want a lot of beating.

In developing quality loudspeakers one is frequently faced with the fact that nature, in establishing basic principles, did not seek the advice of loudspeaker engineers and the wavelengths of low-frequency sounds were made much too long. It is much too late to alter this now that all the text books have been printed and we must make the best of a bad job. Some speakers, according to their makers' specifications, solve the problem by ignoring the basic facts altogether but, somehow, never seem to be so satisfying in performance as one, such as the Klipschorn, which prefers to tackle it in a more complicated manner.

The Vitavox Klipschorn Reproducer

At the same time, the statement "In many cases this is not due to any inherent dishonesty on the part of the manufacturers concerned" implies that there are some British loudspeaker manufacturers who, are in fact, inherently dishonest, a statement which to our knowledge is quite unfounded.

On the subject of Radiolympia, we would mention that this is quite a flourishing affair really and was not held in 1948 merely because the trade had more orders than it could possibly meet and not because it could not afford it as Mr. Hartley suggests. Last year 395,465 people paid to come and see the products that the Radio industry was trying to sell them and the majority of reputable manufacturers took part. Mr. Hartley, for reasons of his own which must be respected, prefers not to participate in Radiolympia.

Demonstrations at these exhibitions are always a problem particularly where high quality equipment is concerned as a large number of the visitors will have only a casual interest. At the last show, reasonably sound-proofed rooms were erected and three loudspeaker firms had sufficient faith in their products to let them be heard by one and all, the other rooms being taken by radio and television set manufacturers. Unfortunately, a strike hindered work and the demonstration rooms were only completed half way through the show and then somewhat hurriedly, so that we were unable to arrange quite so elaborate a demonstration as we had intended.

Loudspeakers are made to be listened to and, in our opinion, it is misleading the public to demonstrate something which they cannot repeat in their own homes. Special recordings and the like were therefore out of the question, and, as we do not manufacture amplifiers, we took three standard models with three commercial pick-ups, typical of the better class apparatus available in this country today, and let people hear whichever they preferred.

The input was from the normal B.B.C. programmes, a special B.B.C. demonstration programme which could be heard in any of the rooms, and standard commercial gramophone records. We even went so far as to invite people to bring their own test records if they desired to do so and quite a number brought records of varying qualities to which they were accustomed to listening.

We certainly had no other complaints concerning the "High non-musical content" to which your correspondent refers although a certain amount of scratch and background noise is unavoidable with a reproducer having an extended high-frequency range and operated from conventional amplifiers and pick-ups. Fortunately not everyone shared Mr. Hartley's view and we sold more Klipschorn Reproducers than we had anticipated in spite of the "bad demonstration" and "inept musical approach."

If we may now be allowed to be a little personal . . . we have found that the snap judgment is the one to be avoided and that the loudspeaker which sounds most impressive at first listening will frequently not stand the test of time. As for the ears becoming conditioned—like a wine taster's palate, presumably—it is our experience that continued listening makes us more sensitive to minor defects.

It wasn't the "maddening smile of ignorant complacency" that our assistant wore—it was an outward symptom of the mental indigestion that occurs towards the end of an exhibition through answering the questions of innumerable people, a few of whom admit to knowing nothing of loudspeaker design, fewer still who know quite a lot, and a great majority who combine the knowledge of the first group with the authority of the second.

J. W. Maunder, for
VITAVOX LIMITED
Westmoreland Road,
London, N.W. 9.

Direct-Coupled Amplifiers

Sir:

We noted Bonavia-Hunt's letters in *Wireless World* (British) concerning his tests on direct-coupled audio amplifiers with some interest. In 1939, we noticed a distinct improvement in quality when direct coupling was used between a diode detector and the first audio stage. Later, we noted an improvement when a .01-μf mica capacitor was shunted across all coupling capacitors.

Power engineering texts state that coupling capacitors in power networks tend to exaggerate higher harmonics because of decreasing impedance with higher frequency. Capacitors are said to develop dielectric hysteresis as well as a dielectric lag or viscosity effect at low frequencies. Studies of wide-band video amplifiers indicate that coupling capacitors tend to help produce non-linear phase-shift and transient distortion, particularly at both ends of the pass band.

Hence, all push-pull, all-triode, direct-coupled audio amplifiers may be the answer to ultra-fidelity.

Ted Powell
5719 69th Lane,
Maspeth, L. I., N. Y.

EDITOR'S REPORT

STANDARDIZATION

For one reason or another, the subject of standardization reappears from time to time on the agenda of this page—probably because once settled for one field, it crops out in another. With magnetic recording in general use for about three years, it seems that standardization should have reached this new industry. Various manufacturers currently employ different methods of equalization—although the final result in each case is the same, and the signal as played back is nearly an exact facsimile of the original.

Presently accepted standards cover only the most necessary points—tape thickness and width, reel dimensions, tape speeds, frequency response limits for the primary and secondary standards, and the limits of flutter and wow.

Tape recorded on one machine may not necessarily reproduce on another within the required limits, since the amount and type of equalization may differ in the two systems; some machines perform all the equalization in the recording process—others split up the equalization. With minor variations, reels are interchangeable on similar *types* of machines.

While methods of measuring signal-to-noise ratio are prescribed, limits of values have not been set up. Within the industry, manufacturers have cooperated to arrive at a reasonable working arrangement for the equalization, but the fact remains that no definite standards have been established.

Some recorders are equipped with plug-in equalizers so that the user can adapt his machines with a minimum of effort in the event of future standardization. Others are so constructed that the change could be made in a relatively short time in the shop. Until standardization is accomplished, the prospective purchasers of new equipment should make sure that equalization can be changed readily, and at reasonable cost.

I R E CONVENTION

As this is written, the annual convention of the Institute of Radio Engineers is being held in New York, together with the Radio Engineering Exhibit which occupies Grand Central Palace for four days each March. Some $7 million worth of equipment is attractively displayed by over two hundred manufacturers.

As always, this convention attracts engineers from all over the country, and the exhibits are always interesting to those who attend. Relatively few audio firms are represented, though, since audio appears to be a small portion of the electronic and radio industry as a whole. A few of the audio exhibits are shown on page 21, these having been photographed on the morning the show opened.

Another meeting of interest to radio people—particularly those in broadcasting—is that of the National Association of Broadcasters, to be held at the Stevens Hotel, Chicago, from April 12th to 19th. The first four days are devoted to the engineering conference, with the remaining four of interest to management.

AUDIO ANTHOLOGY

Publication date, June 15, 1950.

This will be welcome news to many readers who so graciously took the time to express their desire for the book of reprinted articles mentioned in the January Letters column. You have helped us make the decision, and the publication date is now definite—"Audio Anthology" will make its bow on June 15th.

The Anthology will consist of most of the articles of interest to the "audio hobbyist," including those which described amplifiers, pre-amplifiers, noise suppressors, volume expanders, tone and loudness controls, loudspeakers, cabinets, and complete home reproducing systems. Over thirty major articles will be included in the 128-page book, which is priced at $2.00 with heavy paper covers, and at $3.00 with stiff board covers.

To ensure getting your copy from the first printing, you may enter your orders prior to publication—although many of you have already expressed your intention. Your orders should be accompanied with check or money order, and the price includes postage.

ERRATA

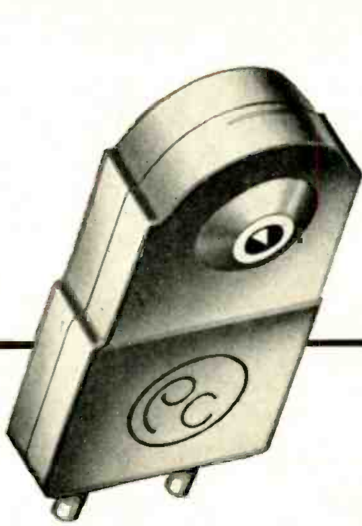
Several minor (?) errors have crept into these pages in the last few months—some as a result of misinformation, others due to carelessness, we regret to say.

The circuit of the Musician's Amplifier, Nov. 1949, shows the output transformer primary connections 6,4,3,1, reading from top to bottom. These connections should be reversed, to read 1,3,4,6. Normal transformer connections are such that the amplifier will oscillate if wired up as shown. An easy check of the correct wiring may be made by removing the feedback loop momentarily, which should cause an *increase* in signal output. If the signal decreases, the connections are wrong.

The parts list for March Audiana failed to include C_{17}. This capacitor should be a 1-μf, oil-filled unit; it was listed incorrectly in the line "C_4, C_{12}—."

On page 18 of the March issue, two curves are shown in *Fig.* 3 with a legend R_3—in both instances, the legend should read R_2.

We trust these errors will not have occasioned any inconvenience to readers who have had time to try out the circuits mentioned.



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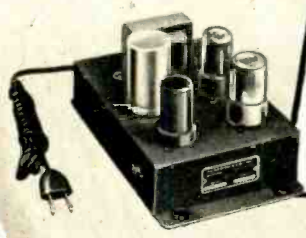
Designed to satisfy the musical ear. A low-cost high quality loudspeaker with smooth wide-range response (within 5 db, 45 to 12000 cycles) and low distortion . . . the only loudspeaker with acoustically adjustable bass response . . . occupies less floor space than any other high quality loudspeaker — less than one square foot.

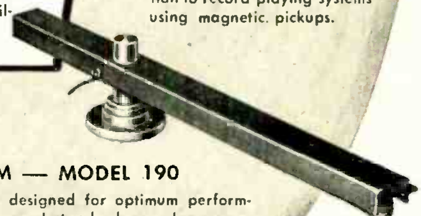
RECORD COMPENSATOR MODEL 132E

This compensator, with 6 positions of equalization, provides the flexibility required to properly equalize for the different recording characteristics used by various record manufacturers . . . it is a most important addition to record playing systems using magnetic pickups.



PREAMPLIFIER MODEL 130H

This preamplifier represents the most advanced design ever achieved in phonograph preamplifiers . . . it equalizes the bass response of records and transcriptions and provides the necessary gain for high quality magnetic pickups . . . its intermodulation and harmonic distortion is exceptionally low — better than most professional equipment.



PICKUP ARM — MODEL 190

The only arm specifically designed for optimum performance on both microgroove and standard records.

- Statically balanced to eliminate tendency to skip when jarred.
- Minimum vertical mass to track any record without imposing extra vertical load on grooves.
- Sensitive tracking force adjustment.
- Magnetic arm rest.
- Rugged frictionless bearings.
- Plug-in cartridge holder.
- One-hole mounting — self-contained levelling screws.

Cartridges used with this arm require 50% less vertical tracking force than when used in conventional arms.

Pickering & Company, Inc.

For the finest audio quality specify Pickering Components

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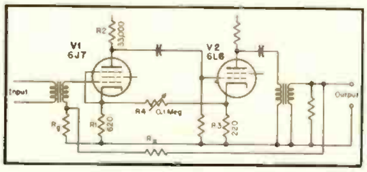
Pickering High Fidelity Components are available through leading jobbers and distributors everywhere . . . detailed literature will be sent upon request.

TECHNICANA

Noise Annoyance

A quantitative method for the determination of a relation between noise and annoyance and the design of a meter for measuring noise annoyance is the subject of an article appearing in *Wireless Engineer* for January 1950. Seventeen sources of noise, including random pulses, AM and FM hiss, record noise, and pulses repeated at rates from 0.1 to 16 cps, were compared with a wide-range band of random noise. The comparison was made by a number of "test listeners" who equated the annoyance and loudness of the various test sounds with the reference noise. Measurements were then made by six types of noise meters and statistical frequency distributions drawn for each test.

From the data thus collected, it was found that a meter indicating "the mean-square value of any input waveform less the mean value (usually negligible or zero)" is a satisfactory meter. A recommended

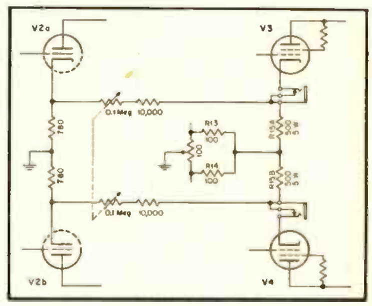


meter is a modification of the mean-square meter in which the sensitivity drops at the rate of 3 db per octave as frequency decreases, changing to 6 db per octave below two cycles per second. This characteristic corresponds to the actual measurements of the annoyance. From this meter characteristic it can be seen that the sounds with high repetition rates are most annoying as are wide-band low-level sources. Although not discussed in the article, an Annoyance Unit immediately suggests itself, based on percentage annoyance from zero or no annoyance to 100 per cent, the point at which the annoyance producing sound is reduced or eliminated by the listener.

Output Impedance Changing

A convenient circuit for changing the output impedance and damping factor of a power amplifier without switching transformer taps or power resistors is described in an article by Thomas Roddam appearing in *Wireless World*, February 1950. The circuit makes use of both positive and negative feedback and is easily applicable in any power amplifier employing 20 db or more of negative feedback. The simple practical circuit developed in the article is shown in *Fig.* 1. With the exception of R_4, this is a conventional negative feedback amplifier with a small amount of cathode degeneration in each stage. The introduction of R_4 adds positive feedback and theoretically permits the plate of V_2 to have zero internal impedance when R_4 is adjusted to the critical point just below oscillation. The large amount of negative feedback around the outside loop will keep the gain constant regardless of the positive feedback up to this point. Recommended operation is at the point where the system sounds best. This technique for adjustment is best because the program quality changes concurrently with the change in output impedance and damping of the loudspeaker.

The article concludes with a suggested application to the Williamson amplifier. The method of implementing this modification in the Musician's Amplifier[1] is shown in *Fig.* 2. The single cathode resistors of V_2 and of V_3 and V_4 have been split to permit positive current feedback across both sides of the push-pull circuit. R_f is the positive-feedback control resistor, and the minimum end section prevents the output impedance from going negative with the occurrence of oscillation. R_f may be a dual 0.1 meg potentiometer, and as in the original circuit adjusted for satisfactory or improved output quality rather than any quantitive measurement.



An additional suggested use for the circuit when adjusted for very low values of output impedance is to feed multiple loudspeaker lines across those speakers which are switched for intermittent use. Under these conditions, the output level will not change as long as the power output capabilities of the amplifier are not exceeded.

[1] AUDIO ENGINEERING, Nov. 1949.

For Golden Ears Only

JOSEPH MARSHALL*

Details of an amplifier design which follows standard practices without any corner-cutting in an endeavor to provide the best possible reproduction.

An audio amplifier which will please 99 per cent of the listeners is not difficult to produce; but bridging the gap between this adequacy and the near perfection necessary to please the hypercritical few Golden Ears is another matter entirely.

The assumption that all that is necessary to produce high fidelity is to provide a wide frequency response has been discredited for many years. It can be taken as the fundamental law that the acceptable bandwidth is inversely proportional to the distortion generated by the system. To attain a bandwidth which will embrace the whole audible spectrum, the system distortion must be held down almost to zero.

The inescapable conclusion is that an audio system intended to reproduce sound with the greatest possible realism must be designed first with the end of reducing distortion to a minimum and only secondly for wide response. With tubes and components available today, it is no trick to produce a wide response. But reducing the distortion to a point which will make this bandwidth tolerable, let alone enjoyable, to the critical ear is a difficult and trying problem.

Three years ago the author constructed a laboratory amplifier for the purpose of investigating the problem of attaining the maximum fidelity and minimum distortion. It consisted of a heavy duty power supply capable of delivering any combination of voltages necessary for a home-type amplifier, and of an audio section whose layout permitted relatively easy and rapid changes of circuits and tubes. Meters were built in to provide easy measurement of plate currents and tube balance, as well as of the output voltage across both resistive loads and loudspeaker and line loads. Literally scores of circuits and modifications have been tried and tested; hundreds of frequency runs and distortion measurements have been made; and all have been checked with critical subjective tests. The decreasing residue of distortion was hunted down until no further improvement could be achieved.

These experiences are expressed in the amplifier to be described. It represents the nearest approach to perfection achieved in the three years of experimentation and, we sincerely believe, the best that can be done with presently available tubes and components. It will deliver 10 watts at any point between 20 and 20,000 cps with less than 1 per cent distortion. Below 8 watts the distortion is so low that it cannot be measured accurately with equipment available to us. The intermodulation distortion is approximately 1 per cent at 10 watts and just over 2 per cent at 15 watts, rising more steeply beyond that. All these figures are with a loudspeaker load.

The frequency response is actually much broader than the 20–20,000 cps mentioned above. Without bass attenuation (described and justified later), the frequency response is down only 5 db at 5 cps and 3 db at 30,000 cps. The design is quite foolproof and can be recommended to anybody with any construction experience at all, providing no changes are made in the circuit or components.

A glance at the parts list will show that the total cost of the amplifier—even if receiver type power supply components are used—will run to around $75. Various short cuts and expedients intended to reduce cost were tried. In fact, we don't believe we missed any possible ones, but the total cost is still a considerable saving over commercial amplifiers with a claimed performance approaching this.

The Circuit

With the exception of a few elements which may lift eyebrows slightly, the circuit and parts are standard and conventional. Briefly, the circuit consists of a single-ended input stage, transformer-coupled to a push-pull triode driver stage, transformer-coupled to push-pull triode output stage. All transformers are of broadcast standard quality, and attempts to use cheaper ones with modifications intended to correct deficiencies proved to be unsuccessful. Some feedback is applied to each stage. A two-stage feedback loop embraces the output and driver stages. The driver stage also has a small amount of current feedback through the absence of cathode-bypass capacitors; and the input stage has the same type of simple current feedback. The main loop provides about 14 db and the others about 4 db each. This feedback produces a high order of damping of the loudspeaker, and accounts partially for the excellent transient response.

Output Stage

The output stage employs 6B4's (6A5G's will give a lower hum level if they can be obtained). This stage operates with fixed bias which is obtained from a selenium rectifier fed by a 6-volt filament transformer in reverse. A resistance-capacitance type of filter could replace the one shown with no sacrifice in performance. The bias voltage is regulated by an OA-3 (formerly VR-75). This may be considered an excessive refinement, but we think not. After monitoring the plate currents of the output tubes for three years we are impressed by the wide variations which occur with relatively minor changes in line voltage. We believe the effects of these variations are minimized by the use of voltage regulation. Furthermore, the voltage regulator tube is an effective hum filter, and since the 6B4 family of tubes has a rather high hum level at best because of the filamentary construction, every possible step must be taken to hold the over-all hum down to a minimum.

To protect against bias failure, a resistor is wired in the filament return circuit and shunted by a 125-ma fuse. The sudden rise of current caused by a failure of the fixed bias will blow the fuse and throw in the cathode resistor, providing cathode-bias operation until the fixed bias is repaired and restored.

The 6B4's are balanced by potentiometers which control the amount of bias applied to each tube. It will be noted that the tubes are neutralized. Our experience, not only with this amplifier, but with others using these tubes, indicates that neutralization is needed in so high a percentage of cases that it might as well be incorporated in the beginning. It is not necessary to neutralize perfectly; if fixed capacitors of approximately 17 μμf are wired in, there is no need to adjust the neutralization further.

The 6B4 family will produce parasitic oscillations at the slightest provocation, as might be expected, considering the high grid-plate capacitance of 17 μμf. The parasitics may not be audible and indeed may well be way up in the r.f. range. But notice what happens to the plate current when the tubes are neutralized—in more than half the cases the

* *Ozone, Tennessee.*

current will be reduced, indicating that there was oscillation, or at least regeneration, at some high frequency.

However. even if no parasitics existed, the neutralization would still be sufficiently desirable for other reasons to be worth the slight cost of the fixed capacitors. Neutralization improves the input admittance of triodes and therefore improves the high-frequency response. It also reduces the effective capacitance shunted across the input transformer, and this moves the resonant peak (due to transformer inductance and distributed and stray capacitance) up into the supersonic range, yielding a smoother and wider bandwidth.

The Driver Stage

In an amplifier using triode output tubes, the critical point is the driver stage. We are convinced that most of the troubles experienced with triode amplifiers are traceable to this stage, and also that most of the residual distortion can be traced to this stage rather than the output stage. Yet little attention is usually paid to this stage—either in the original design or in trouble-shooting—when the design fails to meet the expected specifications.

A signal in excess of 100 volts grid-to-grid is required to obtain maximum output from the 6B4 family of tubes. The tube manuals indicate that there are any number of tubes capable of producing an output of 100 volts or more in push-pull. In actual practice, however, it is very difficult to obtain this much drive without distortion, particularly if feedback is used.

In this amplifier, a high-quality transformer couples the drivers to the output tubes. A considerable sum of money could be saved by eliminating this transformer, and we have made repeated attempts to do this; but we can say categorically that if nearly-perfect reproduction is desired, the saving is not worth the troubles produced. As a matter of plain, though possibly incredible fact, we found no combination of tubes and resistance coupling which would provide the necessary drive for maximum output with fixed bias without excessive distortion. (See Appendix.)

The drivers are a pair of 6C4's, by far the best of the tubes tried for this purpose. They will not only supply a higher driving voltage more easily, but their input admittance is low because of low grid-plate capacitance. This is reduced even further by cross neutralization with fixed 1.5 $\mu\mu$f ceramic capacitors. No adjustment of neutralization is necessary. The neutralization is especially desirable if the smaller of the specified input transformers is used; these have a relatively low resonant point, and the neutralization helps move it upward.

A balancing control is incorporated for the drivers. It consists of a small pot in one cathode circuit. Balance is most easily adjusted by connecting a voltmeter from plate to plate and adjusting for zero voltage difference—preferably at near maximum drive.

We found, however, that the static balance obtained this way is not sufficient to insure balance over the full dynamic and frequency range. Actually, the tubes will remain balanced only over a small portion of the range. To provide dynamic balance, a choke is incorporated in the common plate circuit. Since this choke is common to both branches, it tends to equalize both the d.c. plate currents and the resultant a.c. voltages, and to keep this stage operating Class A—with no variation in plate currents.

The Feedback Loop

Originally we tried the type of feedback using a 10 per cent feedback winding on the output transformer. This is common practice with tetrodes. Such transformers are not commercially available for triodes. However, we had one made to order for these experiments. The idea was to eliminate the phase shifts at the extremes of the frequency range due to resistance-capacitance networks. The idea was abandoned after many trials, though with reluctance. The desired part of the result was achieved—unfortunately, not without undesired effects. It is difficult to run this type of loop over two stages with transformer coupling, and the loop had to be confined to the output stage alone. But ten per cent feedback to the grid of the output stage increases the required driving voltage by more than a third—from approximately 100 to over 130 volts grid-to-grid. It is almost incredible that this much drive cannot be supplied without distortion—even with a step-up transformer—but it turns out to be a fact. The 6C4's come closer to it than any other tubes, but even they generate measurable distortion at maximum drive. So the idea was abandoned after many combinations of tubes and circuits were tried.

Since drive is the critical point in a triode amplifier, it is obvious that the best point to apply feedback is to the input of the driver tubes where the difference feedback makes in drive requirements can be compensated for most readily. To avoid frequency discrimination and excessive phase shift in the feedback network, the capacitors are large electrolytics shunted by paper capacitors. for low reactance at both low and high frequencies. This loop provides about 14 db of feedback without increasing the drive problem. With the transformers specified, no trouble should be experienced with this feedback loop.

Phase Inversion

A transformer is used for phase inversion. This, too, reflects a great deal of effort to get along without it. Every type of vacuum-tube phase inverter we could find references to was tried in these experiments. Two gave acceptable performance but were dropped for different reasons. (See Appendix B.)

The transformer provides a 2-to-1 step-up ratio, but since the feedback loop increases the required input level to nearly 50 volts, additional amplification was necessary to bring the amplifier input level to about 1 volt. Another 6C4 is used in the final model. The only notable point about this stage is the use of a OD-3 (VR-150) in the plate circuit.

The voltage regulator tube provides three important good effects: first, it stabilizes the voltage to this stage, and since it is single-ended this is about the only way to insure stable, undistorted operation under varying line voltage. Second, the regulator tube is possibly the best of all hum filters. Third, and most important, it is the best decoupling element at low frequencies—much superior to any combination of choke or resistor and capacitor. In an amplifier whose low-frequency response goes below 20 cps, decoupling is extremely difficult, and even if there is no actual motorboating, there is enough regeneration to produce a considerable hangover and transient distortion, especially when a feedback loop is involved. The regulator tube provides sufficient decoupling so that the lowest audible frequency will not produce any form of feedback and the hangover is minimized though a trace will show on the scope at 20 cps.

Parallel feed is used for the input transformer, and a switch provides for a change in coupling capacitance. With the 0.1 μf capacitor we get a slight rise at 70 cps and a sharp cut-off below 50 cps; with the 0.5 μf capacitor we get a flat response down to about 20 cps, and a gradual falling off below that.

A low-frequency response which is flat to below audibility is necessary for good transient response, but it is not the complete blessing it might seem. As a matter of fact, with the 0.5 μf capacitor, this amplifier has a response which goes down almost to direct current. It will respond readily to signals which are below audibility, such as the low frequency produced by short-wave fading or that produced by a phonograph record whose hole is eccentric.

It is true that these signals are not audible, nor even measurable on ordinary volume indicators. However, they are of high amplitude as compared with the signal and will drive the output tubes into the Class B region of their operating curves, as the plate-current meter will readily demonstrate. Even at low signal levels, where the signal itself is barely sufficient for an output of 100 milliwatts or less and undistorted output, the inaudible transient is producing nearly maximum distortion. This results in serious intermodulation distortion on the desired signal at a listening level at which we should have none at all.

The best cure is a switch which will modify the low-frequency response to conform with the signal situation. We are convinced that a good deal of trouble experienced with high-fidelity designs is accounted for by this response to inaudible signals whose intensity is high enough to drive the output tubes into non-linear operation at levels 20 or 30 db lower than the design calls for.

The secondary of the transformer is shunted by a resistor which should be adjusted in value to produce the flattest possible response and to eliminate or reduce any peak which the input transformer may contribute to the over-all response.

Conclusion

Our three years of experimentation convince us that this amplifier is as good an amplifier for home listening purposes as can be built with presently available tubes and components. It is possible that additional improvements could be obtained by the use of specially designed transformers—those employed here are standard commercial items. Operating at levels below 8 watts, it is essentially distortionless and can therefore be used in the laboratory for measurement purposes. The small residual distortion in the highest 3 db of the range is insignificant from an aural point of view. Given a good loudspeaker system and a signal source of low inherent distortion, it provides a high degree of realism and—perhaps more important—almost no ear fatigue. The best phonograph records, for instance, sound so nearly like the live prototype that only direct comparison could reveal the difference. Because of the lack of resonant peaks, the scratch level with good magnetic pick-ups is quite low, and with the best available records it is possible to dispense with high-frequency roll-offs—providing the speaker system does not have a pronounced peak in the 2 to 6 kc range—and the listener has a tolerance for a small amount of scratch.[1]

But the amplifier alone is no guarantee of perfect reproduction. Experiments reveal that distortion masks distortion and that the elimination of one component of it reveals another underlying layer. This amplifier will therefore reveal distortion which before was relatively unimportant. For instance, the diode detector in AM receivers will be irritating with this amplifier. Moreover, too many stations—FM as well as AM—are still content merely to meet FCC specifications on distortion, instead of improving on them. The great variation in distortion characteristics of phonograph records, not only of competing companies, but even in the output of one company and the run of one recording, has been noted by many listeners.

However, this amplifier will take the listener the longest part of the road to perfection, and the total effect, even granting the inadequacies mentioned above, is worth several times the cost to anybody whose ears are golden enough to be irritated by the inadequacy of ordinary reproducing systems. Distortion doesn't always add; on the other hand, sometimes it multiplies. The elimination, or virtual elimination, of the substantial amount contributed by the amplifier provides the greatest—almost the only—improvement within our means. When enough Golden Ears possess equipment which will reveal the inadequacies of program material and produce a sufficient demand for improvement, manufacturers and radio stations will be forced to provide it. The sermon is included merely to warn that the amplifier is only *one* element—if perhaps the most important—and that it is not sufficient in itself to guarantee perfect reproduction.

[1] *(The de-emphasis network is still considered necessary.—Ed.)*

[*Continued on page 32*]

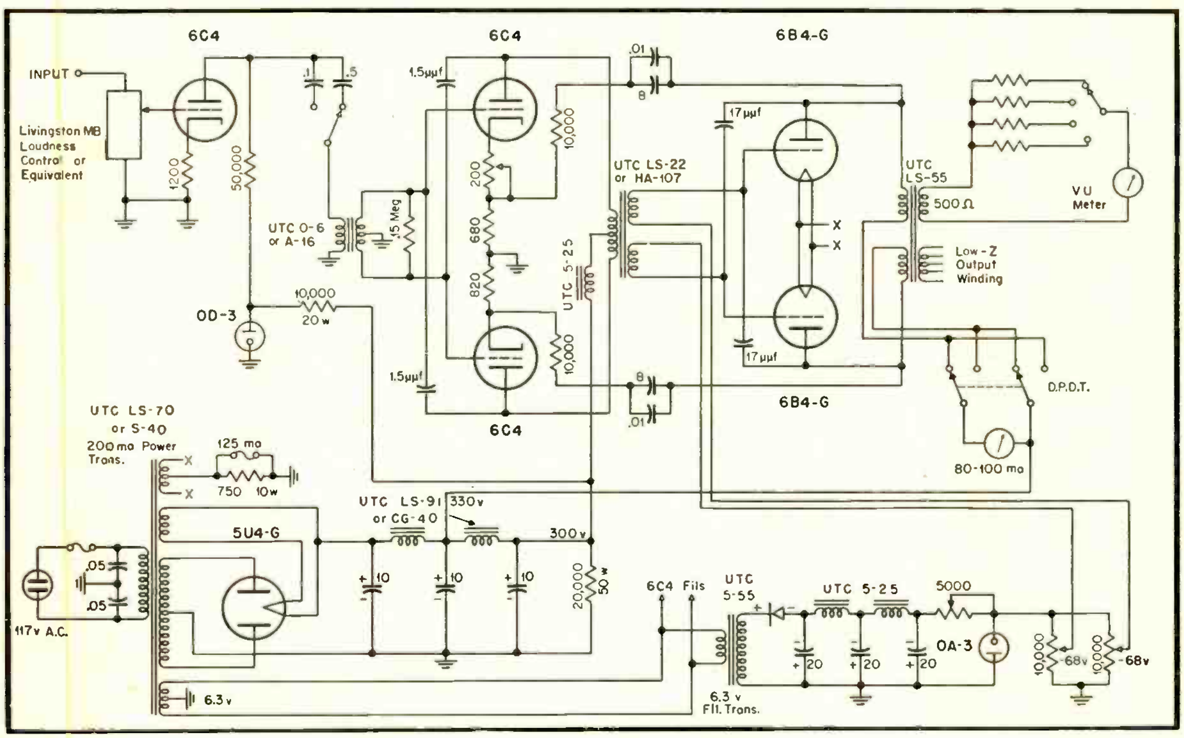


Fig. 1. Schematic of the "Golden Ear" amplifier.

The KB-3A High-Fidelity Noise-Cancelling Microphone

L. J. ANDERSON* and L. M. WIGINGTON**

A new microphone design of especial interest to broadcasters and public address system operators for close-talking applications.

THE NEED has long existed for a high-fidelity, close-talking microphone which will provide better discrimination against background noise than do present microphones.

In broadcasting, there is need for a close-talking microphone which can be used successfully in connection with audience participation programs which use public address systems. It is extremely difficult to maintain a satisfactory level from the P. A. system without encountering acoustic feedback when conventional microphones are used. A close-talking type of microphone is also needed for broadcasting or announcing sports events where information is to be relayed to the sport-caster by assistants without interference with the running comment. A microphone having these same features is also needed for man-of-the-street programs where undesired side comments from bystanders must be eliminated. Equally important is the need in the P.A. field where systems must be operated at high values of acoustic gain without feedback.

To fill these needs, a microphone must have the following characteristics: it should discriminate against a distant sound source or random noise to as great a degree as possible; the response-frequency characteristic should be flat over the frequency range for speech when the sound source is close to the microphone; the output level should be relatively high in order to assure a good ratio of signal to electrical noise. The microphone should be insensitive to breath puffs resulting from closeness to the talker's mouth; the distortion must be low for relatively high sound pressures; and the microphone should be small in size and light in weight so that it may be easily handled.

* *Supervising Engr.* ** *Design Engr. Microphone Engrg., Engrg. Prods. Dept., Radio Corp. of America, Camden, N. J.*

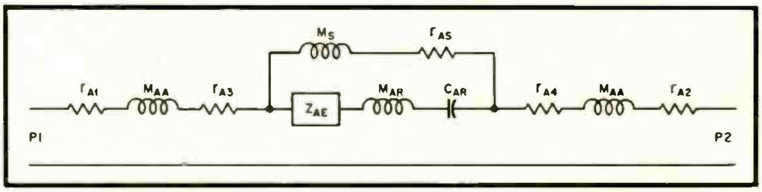


Fig. 1. Equivalent acoustical network of a velocity microphone.

r_{A1}, r_{A2} = acoustical resistance of the air load on the front and back of the ribbon
M_{AA} = inertances due to the air load on the ribbon
M_{AR} = inertance of the ribbon
C_{AR} = acoustical capacitance of the ribbon
Z_{AE} = acoustical impedance due to the electrical system
M_S = inertance due to the slit between the ribbon and the pole piece
r_{AS} = acoustical resistance due to the slit between the ribbon and the pole piece
r_{A3}, r_{A4} = acoustical resistance added between microphone screens
P_1, P_2 = sound pressure at the front and back of the ribbon

Talking close to a pressure microphone or talking loudly will help to some extent in realizing the desired objective; however, a gradient microphone is especially effective because it discriminates against a distant source in favor of a close source over a good part of the audio-frequency range. In addition, the gradient microphone discriminates against random sound because of its bi-directional characteristics.

Many close-talking gradient microphones have been made, although most of them have been designed for services where the fidelity requirements were low. An example of this class is the noise-cancelling carbon microphone built during the war and used extensively in military service. Limitations due to noise, restricted frequency range, and distortion are the principal factors which preclude the use of such microphones in systems where fidelity is important.

The well known velocity ribbon microphone is one of the finest and simplest first-order gradient microphones for high fidelity. The use of this type of microphone for close talking has never been considered desirable or feasible because of the excessive low-frequency response obtained under such conditions and because of its sensitivity to excitation by breath puffs. Recent work done in an attempt to improve the windscreening of small velocity microphones has led to the development of the KB-3A, an excellent microphone in which close talking and discrimination against noise are accomplished with a ribbon element as the moving system. The theory of operation is explained in a simplified form in the following discussion.

Theory of Operation

If in *Fig.* 1 the values of r_{A3} and r_{A4} are made equal to zero, the diagram represents the equivalent electrical circuit of the acoustical, mechanical and electrical elements of a simple velocity microphone.[1]

Figure 2 shows the impedance of the various circuit elements as a function of frequency, and in addition, shows the driving force per unit of free field pressure $\Delta p/p$ which is equivalent to

[1] H. F. Olson, "Elements of Acoustical Engineering," Chapter VIII, pages 252–253.

$(p_1 - p_2)/p$ in *Fig.* 1. The curve $\Delta p/p$ is the driving force obtained when the velocity microphone is driven by a plane progressive sound wave or from a distant source.

The output voltage from the microphone will be

$$e = Bl\dot{x}$$

where B = flux density
l = length of ribbon
$\dot{x}$ = velocity of the ribbon

and
$$\dot{x} = \frac{\Delta p}{A_R Z_{AT}} = \frac{\Delta p}{(X_{AA} + X_{AR}) A_R}$$

where Δp is the total driving force for a free-field sound pressure p
A_R = area of the ribbon
Z_{AT} = acoustical impedance of the vibrating system
X_{AA} = acoustical reactance of the air load on the ribbon
X_{AR} = acoustical reactance of the ribbon mass.

The above relationship holds over a large part of the frequency range and as long as Δp is rising with increasing frequency at the same rate as X_{AA} and X_{AR}, the output voltage will remain constant.

If the microphone is placed close to a small sound source, the value of $\frac{\Delta p}{p}$ will be modified by a factor which will depend on the frequency and the distance to the source. The relationship is shown below.[2]

$$\frac{\Delta p}{p}(r) = \frac{\Delta p}{p}(\infty)\sqrt{1 + (c/2\pi f r)^2}$$

where c = velocity of sound
f = frequency of source
r = distance to the origin of the spherical wave.

The curve $(\Delta p/p)$ (3/4) in *Fig.* 2 shows this effect on the value of $\Delta p/p$ when the source is at a distance of 3/4 in. from the microphone. From the trend of this curve, it is obvious that the response of the microphone is no longer a constant with respect to frequency at this distance from the source, but will rise with decreasing frequency starting at about 3000 cps. The rise expressed in db is shown in *Fig.* 3. This is simply an accentuation of the familiar "boomy" effect which results when a velocity microphone is used at short distances from the sound source.

When the microphone is to be used only for close talking, this effect can be put to a useful purpose. It will be further observed from *Fig.* 2 that for frequencies below 1500 cps that $(\Delta p/p)$ (3/4) is very nearly a constant with respect to frequency. In order to make the microphone output voltage a constant with respect to frequency for this condition, it is therefore necessary that the mechanical impedance of the moving system be independent of frequency over this range. This is readily accomplished by the insertion of suitable values of r_{A3} and r_{A4} in the circuit.

The effect on Z_{AT} is shown at (1) in *Fig.* 2 when r_{A3} and r_{A4} is equal to 10 acoustic ohms. Again it will be noted that the value of $(\Delta p/p)$ (3/4) and Z_{AT} (1) are parallel functions and as a result the output will be independent of frequency as long as the microphone is 3/4 in. from the source. The sensitivity to a plane wave will, however, fall with decreasing frequency, the amount being proportional to the ratio of

$$(\Delta p/p)\ (\infty) \text{ to } (\Delta p/p)\ (3/4).$$

In actual practice, the necessary resistances r_{A3} and r_{A4} are added to the acoustic system by placing layers of cotton or fiber glass between the inner and outer screens of the microphone unit. The response-frequency characteristic of the microphone for a small source 3/4 in. distant is shown at (1) in *Fig.* 4, and is as predicted essentially flat over the audio range.

Performance Characteristics

The measured response of the microphone to sound originating at a distance from the microphone is shown at (2) in *Fig.* 4. From this it can be seen that the

[*Continued on page 30*]

[2] L. L. Beranek, "Acoustic Measurement," Chapter V, page 230.

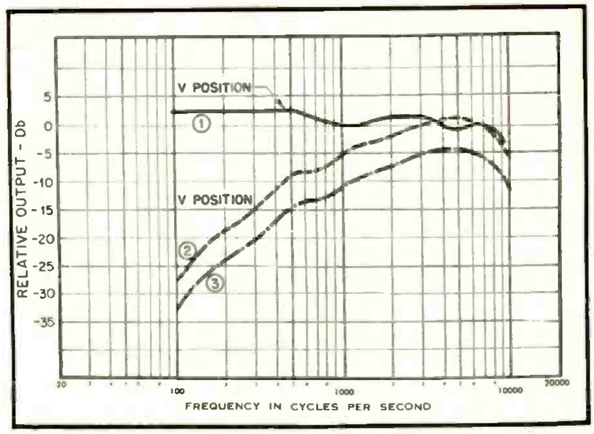
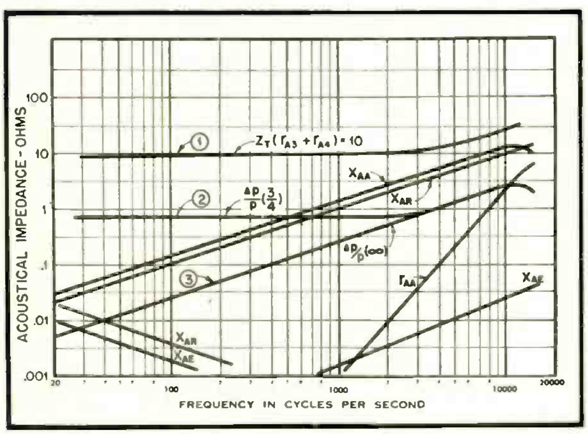


Fig. 4. Measured response of Type KB-3A close-talking microphone.



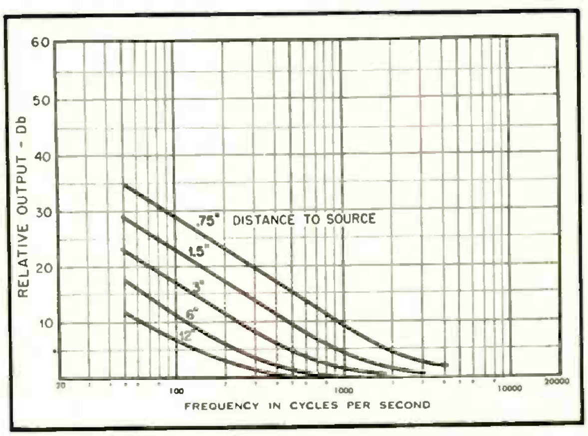


Fig. 2, left. Acoustical impedance characteristics of a velocity microphone. Fig. 3, right. Effect of source proximity on velocity microphone response.

Magnetic Recording in Motion Pictures

M. RETTINGER*

PART II. The fundamental aspects of magnetic tape recording, particularly for motion pictures, including a description of magnetic recording, reproducing and erasing head construction, and a discussion of a.c. biasing, together with experimental results.

In order to discuss the frequency response of a magnetic recording, it appears desirable to assume constant-current input to the recording head. In practice, constant-current input is approximately accomplished by either connecting the head to a high-impedance source, such as a pentode, or else by placing a high resistance in series with the head. While a pentode is the most economical generator for the purpose, the harmonic distortion from such a source is considerably higher than from a triode. A series resistance, of course, incurs a power loss, which may be as much as 20 db or more at 1000 cps. To illustrate the condition, consider a recording head of 8-mh inductance. On the assumption that its inductance is independent of frequency and its resistance small compared to its reactance within the frequency range considered, the impedance at 100 cps will be 5 ohms and at 10,000 cps it will be 500 ohms. A 5000-ohm resistance in series with the head will provide substantially constant current to the head when the combination is connected to a 500-ohm constant-voltage generator.

Neglecting for the moment demagnetization and gap effects, constant sinusoidal current through the recording head should induce, in the recording medium, a constant remanent flux given by:

$$\phi = \phi_{max} \sin \omega t.$$

During reproduction, the open-circuited induced voltage from the reproducing head having a coil of N turns—again neglecting some factors to be discussed later—will be proportional to the rate of change of flux, as given by:

$$E = -N\frac{d\phi}{dt}10^{-8} = -N\,\phi_{max}\,\omega 10^{-8} \cos \omega t$$

$$= 4.44\, f\, \phi_{max}\, 10^{-8}\ v,\ (Eff.\ Value)$$

When the recording medium is moving past the reproducing head at a speed different from that at which it was recorded, a change in frequency occurs. The new frequency is given by

$$f_1 = f_0 \frac{V_1}{V_0}$$

where V_0 = speed of medium employed in recording

V_1 = speed of medium employed in reproduction

f_0 = recorded frequency

The change in output level is given by

$$db = 20 \log \frac{V_1}{V_0}$$

Thus, as the tape speed is doubled in reproduction, the output level will increase by 6 db. That is, the output level of what was formerly f_0 will be 6 db greater at the new reproduced frequency $2f_0$. It may be noted that the output voltage from the reproducing head at low medium-high frequencies is independent of the velocity as long as the signal is reproduced at the same velocity with which it was recorded.

Demagnetization (the reduction in remanent flux on the recording medium as the wave length is decreased) is a function of the geometry of the recorded flux pattern and of the coercive force of the recording medium. The greater the coercive force, remanence remaining constant, the less will the little magnets on the tape be able to demagnetize themselves. As far as the high frequencies are concerned, the effect of increasing the coercive force, thus, is similar to increasing the speed of the recording medium; that is, the output at the high

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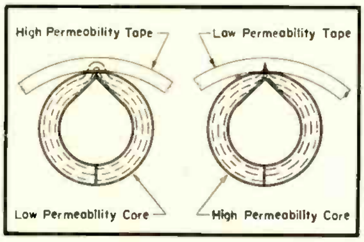
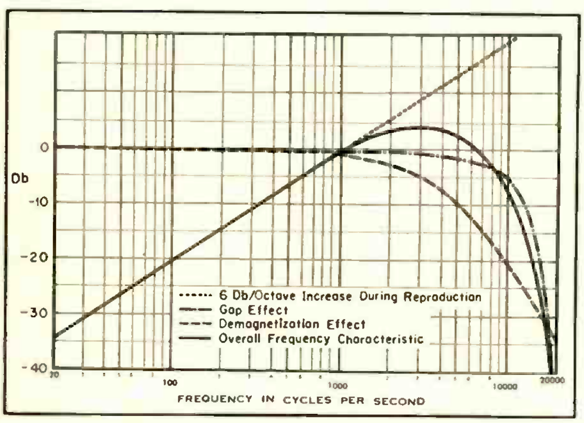


Fig. 15. Distribution of flux for heads and tapes of differing permeabilities.



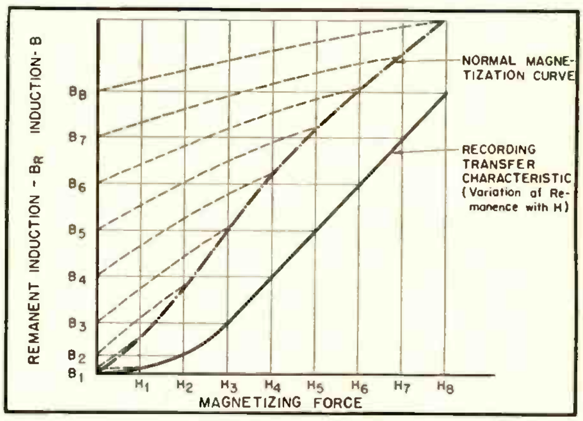


Fig. 16. (left) Factors entering into the development of output curve for reproducing head. Fig. 17. (right) Comparison of remanent induction for recordings made with and without high-frequency bias.

frequencies is increased while that of the low frequencies remains the same. Unfortunately, the larger bias current required for the high-coercive force media in turn effects a reduction in high-frequency output from the tape so that the net result, in practice, may be inconsequential. Increasing the remanence, coercive force remaining constant, effects a greater output level for all but the very high frequencies. A decrease in output level at the high frequencies results when a high-permeability medium is used, as illustrated in *Fig.* 15. The leakage flux lines from the air gap of the recording head, seeking the path of least reluctance, lose their peaky distribution character and become bulgy, the more so the smaller the permeability of the core relative to that of the medium.

During playback, there is a slight recovery in induction at the shorter wavelengths as the recording medium passes over the reproducing head, since the poles on the medium become neutralized by the magnetic core of the head. This neutralization exists only as long as the poles on the tape are in contact with the head, after which they return to their original state of magnetization after leaving the head. The head thus acts somewhat as a "keeper."

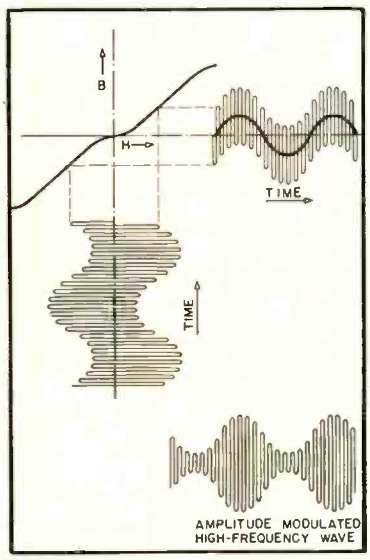


Fig. 18. Input/output curve for tape recording when high-frequency bias is used.

The dotted line of *Fig.* 16 shows the 6 db per octave increase in the output of a reproducing head when the recording head is energized with constant current, demagnetization and gap effects being neglected. The dot-dash line of *Fig.* 16 represents the high-frequency attenuation due to the gap effect (discussed in Part 1). The dashed line shows for a particular type of recording medium the effect due to the demagnetizing forces. The solid line of *Fig.* 16 gives the theoretical frequency response of a magnetic recording when gap and demagnetization effects are considered.

A flat frequency-response characteristic is provided for the over-all system when the frequency response of the reproducing amplifier is made equal to the inverse of the solid curve of *Fig.* 16. Sometimes this equalization is "split," with part of the high-frequency compensation introduced in the recording amplifier.

What happens when a magnetic recording is made on a magnetically neutral tape in the absence of a bias may be illustrated in *Fig.* 17. The dot-dash line shows the normal magnetization curve of the recording medium, with B_1, B_2, B_3, etc., indicating the remanent induction values on the medium after it has passed the recording gap. The solid line represents this remanent induction as a function of the magnetic field. This curve is known as the recording transfer characteristic for low and medium-high frequencies; the non-linearity of this curve about the origin gives rise to a marked distortion when no bias is used.

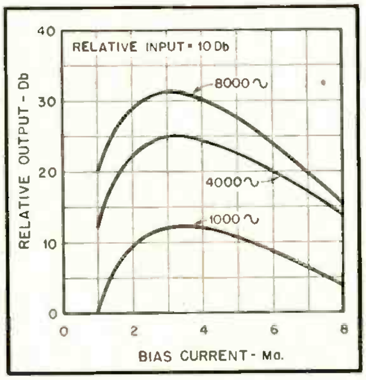


Fig. 19. Effect of bias current on output level for different frequencies.

The addition of a supersonic bias causes the recording characteristic to be linear about the origin, as well as symmetrical in the first and third quadrant, thus preventing the production of even harmonic distortion. According to Toomin and Wildfeuer[1], when the bias current is such that the magnetomotive force which it produces approaches the coercivity of the medium, the added signal current produces a shifting of the minor (bias) hysteresis loops vertically inside the major loop in such a manner that the remanent (signal) induction on the medium is proportional to the distances on the straight portions of the major loop along which the minor loops are shifted by the signal magnetomotive force. Thus, a quarter cycle of a 100-cps signal current superimposed on a 50.000-cps bias current "envelops" 125 complete alterations of the bias current; every minor hysteresis loop produced by these 125 alterations of the magnetomotive force is progressively displaced within the major loop, the tips or peaks of the minor loops sliding with uniform velocity along a branch of the major loop. It should be noted, however, that the symmetrically alternating bias current alone produces in the recording medium a symmetrically cyclically magnetized condition in which the mean values of both induction and magnetizing force are zero. The bias current thus tends to keep the recording medium in a magnetically neutral state when no signal is recorded, with a consequent reduction of background noise.

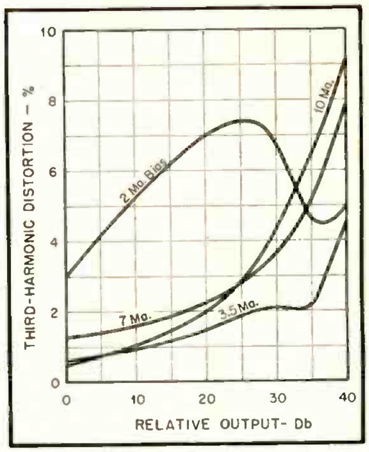


Fig. 20. Distortion/output curves for varying amounts of bias current.

According to Holmes and Clark[2], the action of the supersonic bias can be explained in terms of input-output curves similar to those used for radio tubes, when the input of the bias and audio field is plotted against time on the vertical axis and the output remanent tape induction is plotted against time on the horizontal axis. Such a curve is shown in *Fig.* 18. The solid signal curve on the horizontal axis is the resulting remanent induction on the tape after the considered portion of the tape has left the air-gap and demagnetization forces have taken their effect. It should be noted again that the signal current is merely superimposed on the bias current; it is not modulating the bias frequency in the manner an audio wave modulates a radio frequency carrier, as shown in the lower right-hand corner of the figure.

[1] H. Toomin and D. Wildfeuer, "The Mechanism of Supersonic Frequencies as Applied to Magnetic Recording," *Proc. I.R.E.*, November, 1944.

[2] L. C. Holmes and D. L. Clark, "Supersonic Bias for Magnetic Recording," *Electronics*, July, 1935.

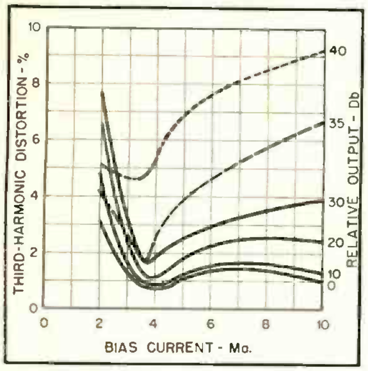


Fig. 21. Distortion/bias current curves for differing output levels.

Experimental Results

Figure 19 shows the effect of bias current on recording medium output level for 1000, 4000, and 8000 cps. It is seen that this level rises at first rapidly and then decreases more slowly with increasing bias current. This decrease is somewhat more pronounced for the higher frequencies and may be ascribed to an erasing action on part of the bias flux in the recording head air-gap. The curves were obtained by supplying constant current to a particular recording head and employing a reproducing amplifier with a flat frequency response; also, the same head was used both for recording and reproducing. It may be noted that another kind of head may not produce peak output at the same bias current for the three frequencies shown in *Fig.* 19.

When harmonic distortion is plotted against bias current, we find that the bias current I_m which gives maximum output from the tape does not, with some exceptions, produce minimum distortion, but that a bias current either slightly larger or smaller than I_m is more suitable in this respect. This is shown in *Figs.* 20 and 21. Whether to use a somewhat larger or smaller bias current—assuming each will provide the same low amount of distortion—will depend on the resulting frequency response: if the larger bias current will reduce the high-frequency response excessively, the lower bias current should be used—unless this lower bias reduces the over-all output excessively. For this reason, it is generally desirable to employ a type of tape which shows a broad maximum when output is plotted as a function of bias current. The distortion measurements were made with a reproducing amplifier whose frequency response above 400 cps decreased 6 db per octave, as it would most frequently under normal operating conditions; with a reproducing amplifier having a flat frequency response, the third-harmonic distortion percentage would, of course, be greater than the amount shown. Third-harmonic distortion measurements are frequently preferred over total distortion measurements, since the latter may contain noise components which would obscure the effects produced by the non-linearity of the magnetization curve of the recording medium.

Figure 20 is of chief interest to the technician operating a magnetic recorder, since it enables him to select the bias which gives greatest output with least distortion. By drawing a horizontal line corresponding to a chosen distortion, he can determine the bias which gives maximum output without exceeding the preselected value of distortion. It should be noted that the curves pertain to a particular type of tape; another type may produce greater output at a similarly low preselected value of distortion, but, at the same time, may require a higher recording level. This latter requirement is usually not a serious consideration, however, since the necessary audio wattage, at any event, is not very large—at least as far as commonly available recording amplifier output capacities are concerned. This is true only as long as the larger recording level does not increase the distortion from the head due to higher flux densities in the recording head core.

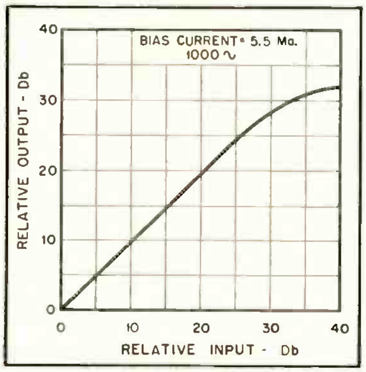


Fig. 22. Typical overload characteristic.

Figure 21 may be used to determine if minimum distortion occurs when the bias is adjusted for maximum output.

It may be noted here that bias values on curves of this type are frequently expressed in "ampere turns," instead of in amperes, in an attempt to provide more general information. However, it has been found that even when the same type of recording head is used on another recorder, somewhat different values of bias are required to achieve identical results, due to capacitance effects in the recording head and associated wiring.

Figure 22 shows the overload characteristic of a magnetic film, and it is seen that there is no sharp break in the curve, as would be the case for variable-area recording when "overshooting" takes place.

Figure 23(A) shows the effect of insufficient contact between film and reproducing head, and it is seen that the resulting loss for a 1-mil air-space between film and reproducing head is far more pronounced for the high than the low frequencies. This can be explained by a consideration of the "elementary" magnets which make up the sound-track, as shown in the insert. It is seen that the flux lines for the longer or low-frequency magnets extend much farther into space than do the flux lines for the shorter or high-frequency magnets. The number of lines, indicative of the remanent induction, is the same for each type of magnet, the lines for the shorter magnets being crowded more closely to the "dipole."

Noise

Two types of signal-to-noise ratio are of interest in magnetic recording. One, conveniently expressed as signal-to-background-noise, gives the ratio of the maximum (440 or 1000 cps) signal that can be recorded and reproduced with a limited amount of distortion (say, 2 per cent) to the no-signal background noise generated in the reproducing head when the frequency response of the playback amplifier is adjusted to provide a flat response for the entire magnetic recording system. The second type of signal-to-

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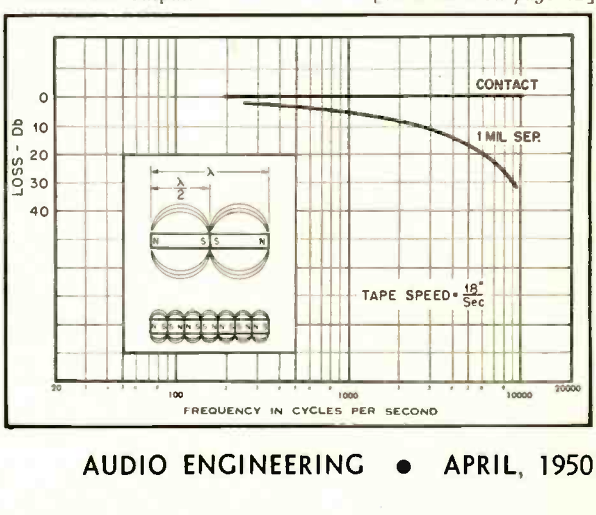
Fig. 23. Curves showing response due to poor contact between head and tape. (Insert) Enlarged section of coating to show magnetic fields.



IRE SHOW

Scenes from a few of the audio exhibitors' booths at Grand Central Palace, March 6th to 9th

Overcoming Fletcher-Munson Effects

NATHAN GROSSMAN* and MEYER LEIFER**

Presenting a simple method of compensating for the natural characteristics of the ear for various listening levels.

RESEARCHES WHICH RESULTED, after many years, in the Fletcher-Munson response curves illustrated in *Fig.* 1, are now finding their way into discussions of the design of audio equipment. Their significance is not always appreciated, and attempts to translate them into the art of audio design are not always adequate or correct.

These researches showed that the ear does not respond equally to different levels of sound, nor equally to different frequencies. The ear seems most sensitive to notes between 3000 and 4000 cycles, and responds poorly to the low frequencies except for loud sounds, and always poorly to the extreme highs. As the listening level decreases, the sensitivity of the ear to low notes falls off sharply.

The average radio listener hears music from his apparatus at a level much lower than the live music which is being broadcast. According to one authority,[1] this level is about 30 db below that of live music, and corresponds to about 55 db on the Fletcher-Munson curves. In order that the ear hear with the same intensity as a 1000-cps note at 55 db, notes of 50, 100, 3000, and 10,000 cycles, require sound levels of 76, 70, 52, and 67 db respectively. In other words, 24 db of compensation is needed at 50 cps, 18 db at 100 cps, and 15 db at 10,000 cps. In addition, a loss of 3 db is necessary at 3000 cps. At lower levels the amount of bass boost required increases rapidly, and may reach a maximum of 35 db or more.

Because of the need for such large amounts of bass and treble boost, equipment for home use should not be performed with a straight line frequency response. If a mirror-effect is made, as in *Fig.* 2, of the Fletcher-Munson curves at 45 and 55 db listening levels, the result shows what an air-to-air system with perfect "flat" characteristic sounds like to a listener at these levels. An addition of 18 db or more in the lows will not necessarily result in boominess or excessive bass, especially where the highs are preserved and the extreme highs accentuated. With the foregoing in mind, several things can be done to improve home listening.

Methods

First, as it is easier to de-emphasize in home equipment than to add emphasis, the broadcast end should introduce emphasis in suitable parts of the sound spectrum. This is not practical in the extreme lows, but can easily be done in the extreme highs. The latter is the standard practice in FM broadcasting. This benefit of FM broadcasting is generally lost in the receiver through intentional de-emphasis. By slight changes in the output circuit of the discriminator or ratio detector, the emphasis of the extreme highs can be retained. This can be accomplished by disconnecting the de-emphasis capacitor, or by putting in a switch at "x" in *Fig.* 3, thereby making the de-emphasis optional. The broadcast emphasis can be turned into another advantage by changing the de-emphasis circuit to conform to the circuit in *Fig.* 4, thereby introducing considerable bass boost below 3000 cps, while retaining much of the broadcast treble boost above that point.

Second, tone controls and tone compensators should be designed to give more than 25 db bass boost and more than 10 db treble boost, and the point of transition should be between 2000 and 4000 cps. This degree of compensation is needed to enable the listener to correct for indaquate bass or treble reproduction from the loudspeaker itself, to correct for losses due to the placement of the loudspeaker away from the corner of the room or on the wall, or, in regard to the highs, facing a wall which is a short distance away. It is also needed to correct for listening level, which may be lower than average, and for listener preference. The selection of a high transition point was made after consideration of many factors. Because this point corresponds to the point of greatest aural sensitivity, no compensation is needed there. The selection of a lower transition point, for example, at 800 cps, results in boosts of 5–10 db in the region of 2000–4000 cps. This has two effects: first, it partly cancels the boost relative to 50 and 10,000 cps; and second, as shown in *Fig.* 2, it increases the peak in the 2000 to 4000-cps region, thereby giving an effect of increased treble without any improvement in tone quality or listening effect. The use of 1000 cps as a transition point for treble increase is common, but this point is only a little better than the 800-cps point. The lowest point for satisfactory treble boost is 1500 cps. However, where a separate bass boost is used, or if bass boost alone is desired, the transition point of 800 cps is satisfactory, as the intensity curves in *Fig.* 1 for needed compensation begin to bend at this point.

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[1] Frequency Range and Power Considerations in Music Reproduction. *Jensen Technical Monograph* No. 3, p. 6.

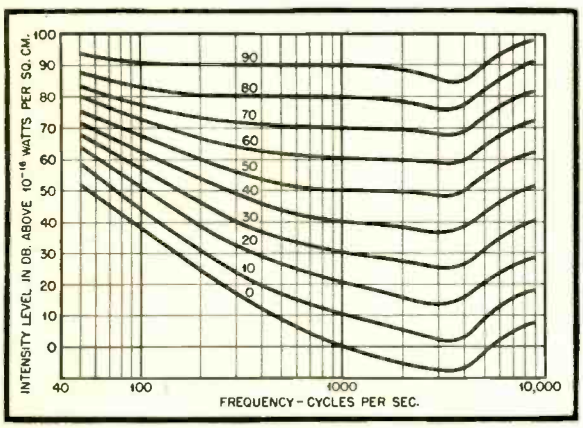

Fig. 1. Fletcher-Munson curves relating response of the human ear to various sound levels.

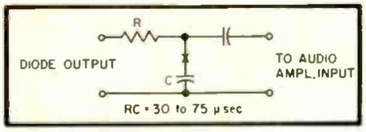

Fig. 3. Usual de-emphasis circuit for FM receivers.

An inadequate tone compensator of an amplifier when matched to a given speaker may result in a mediocre listening reaction, despite the wide range and other good qualities of the loudspeaker and the driving amplifier. It is important to know the characteristics of the loudspeaker to be used before designing or selecting an amplifier to drive it. Manufacturers can, therefore, be helpful by furnishing with each speaker sold, in addition to the usual information concerning voice coil impedance and power handling capacity, a frequency response curve for the particular model.

Lately, a number of bass compensators have been designed or put on the market which are capable of giving sufficient bass boost. Most of these compensators correlate the amount of the boost with the setting of the volume control. As a result, the amount of bass boost furnished at any given position of the volume control may not coincide with the amount of boost required for realistic listening. Moreover, with such an arrangement it is not possible to compensate for speaker efficiency, characteristics, or position, nor for room acoustics or listener preference.

Compensator Circuit

After considerable experimentation, the authors decided upon the tone compensator circuit shown in *Fig.* 5. This circuit is a voltage divider operating in two ways. By removing the 200-μμf capacitor from the circuit (by opening the the switch), the treble range above 3000 cps is depressed. If, instead, the .005-μf capacitor is shunted to ground (by moving the arm of R_2 to the left), the range below 3000 cps is depressed in level. With both capacitors in the circuit, the action is similar to that of a 3000-cps elmination filter. For various settings of R_1, the response curves are shown in *Fig.* 6, where it can be seen that this compensator will provide realistic listening at softer than average home radio volume, and that there is sufficient leeway to compensate for such other factors as listener preference, loudspeaker characteristics, and so on. By increasing the resistance of R_1 to maximum, two things take place: first, the response curve becomes more flat; and second, the transition point is lowered from 3000 to 1500 cps. The resistor values chosen should theoretically furnish more compensation; however, from actual testing, it was found necessary to increase the voltage-divider ratio in order to overcome the losses in the circuit.

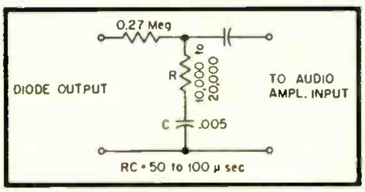

Fig. 4. Modified de-emphasis circuit.

A switch has been placed in the treble boost circuit so as to make the treble boost optional. The potentiometer R_2 permits variation of the bass compensation while retaining a fixed treble boost. This may be desirable when playing records with smaller amounts of bass compression, or when using a record player pick-up which has a heavy bass compensation.

The circuit in *Fig.* 5 may be separated into treble and bass boost parts and placed in different parts of the amplifier. The bass boost circuit may be used without the treble boost where there is

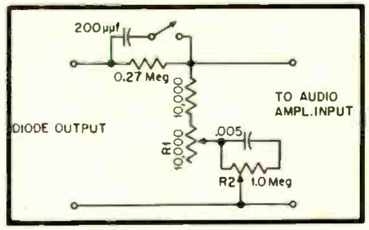

Fig. 5. De-emphasis circuit with variable controls of both high and low frequencies.

no de-emphasis in the FM receiver. Although the treble boost may occur elsewhere in the reproducing system, the final effect would be the same as if the circuits were joined in one. The *RC* constant of the bass compensator will determine the transition point of the entire system if it is at the same or at a higher frequency than the *RC* constant of the treble compensator.

It may be desirable in some instances to use a treble boost which is separate from the bass compensator, especially where considerable treble boost is needed to compensate for the 10–15 db losses which occur at 10,000 cps in most loudspeakers in addition to the compensation which is required for proper aural effect. If this amount of treble boost is used, an additional stage of amplification is necessary becauses of the losses in this circuit. The gain required should be determined by experiment before designing the stage.

Operational Results

The circuit of *Fig.* 5 was put into an audio amplifier and used with two different speaker arrangements. With one, the best listening effect at the usual listening level was noted at a 7000-ohm setting of R_1, while with the other the optimum setting was at 2000 ohms. These settings were arrived at by increasing R_1 by steps

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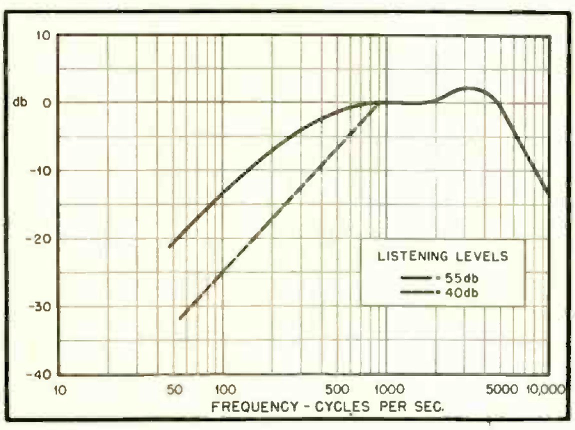

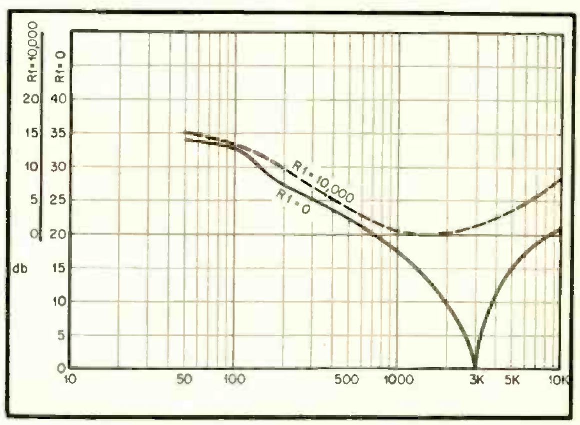

Fig. 2, left. Net response to ear for a "flat" system at low listening levels. Fig. 6, right. Curves obtainable with circuit of Fig. 5.

A New Hygrometric Chart

"STYLUS"

NOW THAT prewar competitive conditions have returned, it is time for us to become conscious of the effect of high humidity on audio components. Such a condition prevails in many parts of the country for several months during the summer.

Resistance is high and reactance is low in the average audio circuit so that the most harmful effect of humidity is the resulting d.c. leakage. The rise in dissipation factor which is so serious at radio frequencies is seldom of importance in audio. By upsetting amplifier bias relations, d.c. leakage can reduce gain, impair frequency response, and increase distortion in a most phenomenal way. A particularly annoying aspect is the speed with which humidity enters a component and the slowness with which it leaves, for it enters in days or weeks, then takes months to leave completely.

In ordinary applications the acrylics, the styrenes, and polyethylene can be considered immune to moisture. For the ultimate in high insulation value at higher cost, Teflon is available. However, for a low cost, high strength, rigid sheet material which will withstand soldering iron temperatures, we are still forced to use the phenolics. There are enormous differences between various base materials and grades, and a given grade may vary a thousand fold between one manufacturer and another. Varnish and silicone fluid impregnation seem to exert little help over a long period of time. The original material seems to be the controlling factor.

Capacitors are extremely susceptible to moisture unless properly protected, and the old cardboard-cased unit is, of course, the worst. In the new field of inexpensive molded paper tubulars, the differences between one maker and another are very great. Even the hermetically sealed are often not what they seem, for the seal itself may develop electrical leakage if the wrong material is used. The glass bushing types seem the most foolproof.

It is therefore necessary to humidity-test most materials and products by long-continued immersion in a humid summer atmosphere—often 100° F. and 96 to 98 per cent relative humidity. Tests for leakage should be made periodically, preferably at the same voltage as will be used in actual service. This precaution is occasioned by the fact that the resistance often drops sharply as the voltage rises, even though far below the breakdown point. A test at 70° F. is not an adequate substitute for one at the higher temperature. The relative humidity may be kept the same, but the absolute value of water vapor pressure will be much less.

Because so many unexpected things can happen when striving to achieve very high relative humidity in a closed chamber, it is necessary to measure humidity as well as temperature. The instrument should be more accurate than the ordinary desk hygrometer, which is of doubtful value at high humidity. The best for the purpose seems to be the wet

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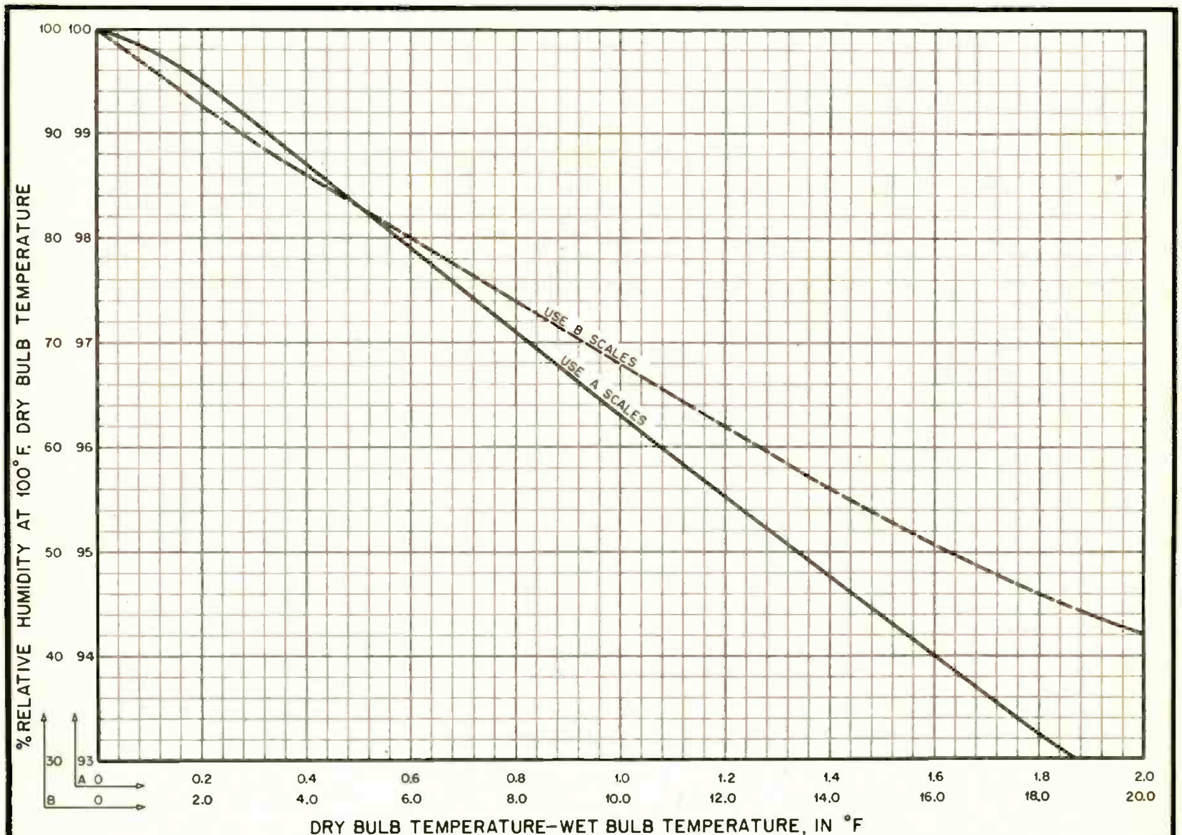
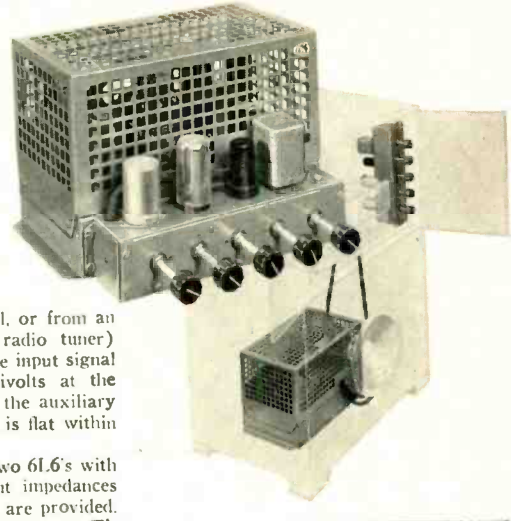


Equipment Report:

Rauland 1825 High Fidelity Phono Amplifier



Interest in commercially available equipment is second only to constructional information in the opinion of many audio enthusiasts, since many users of this apparatus prefer to purchase ready-made standard amplifiers and other devices rather than trying to construct them in their own workshops.

The Rauland 1825 High-Fidelity Phono Amplifier has several unique features which make it especially desirable for the residence installation, and one of these is the method of mounting. As seen in the photograph, the amplifier is a compact and self-contained unit of more or less conventional design with the preamplifier attached to the main chassis. However, the entire preamplifier may be removed and mounted adjacent to a tuner or phono turntable or in any convenient location up to three feet from the main chassis. The control panel can be interchanged with the bottom plate of the preamplifier so that the tubes extend back from the panel, and the mounting brackets can be rotated to any position for attachment to the cabinet or panel, as shown.

Performance

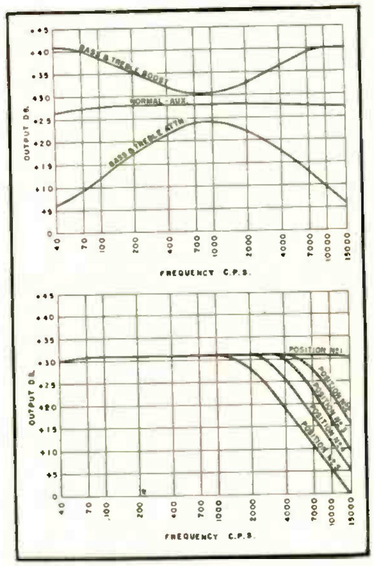
Flexible tone controls provide response curves as shown at right, with a 10-db boost or cut at 70 and 10,000 cps. A switch selects inputs from the phonograph preamplifier with a gain of 103 db over-all, or from an auxiliary input (such as a radio tuner) with a total gain of 78 db. The input signal for rated output is 2.8 millivolts at the phono input, or 0.21 volts at the auxiliary input, and frequency response is flat within ± 1 db from 37 to 21,000 cps.

The output stage employs two 6L6's with 17 db of feedback, and output impedances of 4, 8, 16, 250, and 500 ohms are provided.

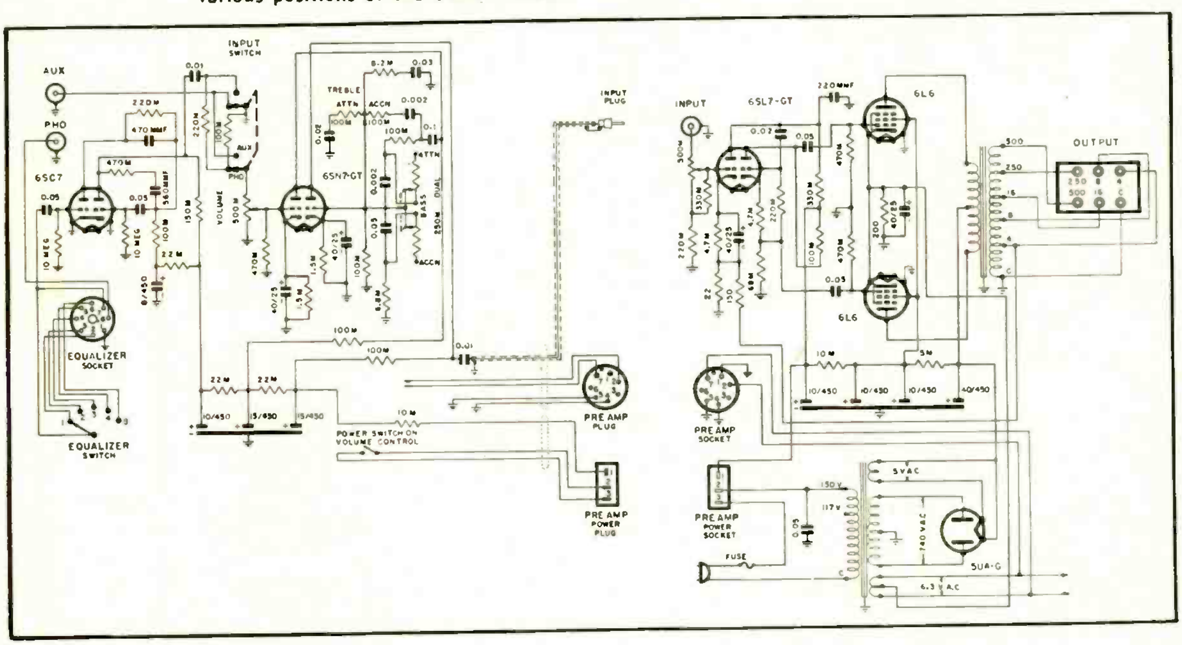
Rated power output is 25 watts, and .E's tests show this to be approximated closely—at five per cent distortion, a measured power output of 22 watts was found at 1000 cps with a line voltage of 114 volts. At 60 cps the output at five per cent distortion was measured at 21.2 watts; at 10,000 cps, 18.6 watts.

Two plug-in equalizers accommodate all types of magnetic pickups, and another is for use with crystal cartridges. The design of these units is such that the same response is obtained with all types of pickups. The cutoff switch provides for flat response, or for a droop of 12 db/octave above each of the four cutoff frequencies.

Distortion remains well below one per cent for average listening levels, and because of its adaptability and comparatively low cost, this amplifier is considered excellently suited for use in home audio systems.



Below: Schematic of Rauland 1825 amplifier. (M in resistor-value listings indicates 1000.) Curves at right, above: Frequency response, and range of tone controls. Lower curves show cutoff frequencies for phonograph reproduction at various positions of the cutoff control.



AUDIANA

C. G. McPROUD

Construction Practice-1

Audio equipment—like any other—must be built before it can be used, and there are almost as many different styles of construction as there are constructors. Fortunately, performance is not nearly as dependent on the actual physical layout and arrangement in the audio spectrum as it is in some others. High-frequency techniques are quite specific, and short leads, socket-mounting of resistors and capacitors, and point-to-point wiring are mandatory if good results are to be obtained. Anyone who has assembled a television receiver from a kit will remember how parts are placed, and how little similarity there is to standard audio practices.

In this series, we shall discuss the physical design and layout of audio apparatus, choice of components, wiring practices, cabling, and many other points involved in the construction of amplifiers and power supplies. This series will not discuss circuit design—that will be assumed complete—but will carry on from that point, considering each step of the work necessary to convert a schematic into a finished piece of apparatus. Circuit design will be covered in a future series.

Initial Steps

In most instances, the builder will have an idea of the size and shape he wishes a piece of apparatus to have. Obviously, the size will be governed by the components required, particularly with respect to transformers, chokes, and filter capacitors. In general, however, these components will rarely need to be replaced, and can be mounted quite close together, with capacitors taking up the space under transformers if necessary.

Assuming that a circuit is complete, the first step is to select the components. Many of these will be indicated by the circuit specifications, particularly transformers—power and audio—and chokes. The use of half-shell power tarnsformers is not recommended for high-gain audio equipment because the chassis—if steel—is likely to have an a.c. field induced in it because it is in direct contact with the transformer core. The mounting with the core perpendicular to the chassis is more suitable. For the finest equipment, completely cased and potted transformers and chokes are desirable, and rarely give any trouble. In humid climates they are almost essential, to avoid failure due to moisture in the windings.

As readers may infer, the writer is a confirmed experimenter, and many of these suggestions may be tempered with a consideration of the possibility of rebuilding and the saving occasioned by re-use of certain of the components, particularly the more costly units such as transformers. For this reason, the transformer types preferred are those having terminals rather than leads, because once cut to a certain length for one chassis, leads may not reach the sockets or terminals in a new one.

The same suggestions apply to power-supply chokes, although space may be at a premium and open-frame chokes can often be mounted under a chassis. Chokes are less expensive than transformers, however, and the need for re-use may be lessened in the interests of space-saving or of economy.

Let it be said firmly, however, that a saving in cost of transformers is precarious—the best obtainable is usually the cheapest in the long run. Transformers have an unusually long life—we have never known a *good* one to fail—and their characteristics remain constant over a long period. Once built into an amplifier or power supply, they may be expected to function perfectly for years.

Capacitors

For the highest class of equipment, it is usual practice to employ oil-filled capacitors for filters. Except for the surplus units that are now available, these units are quite expensive, but their power factor is considerably better, they are more efficient in filter circuits, and less capacitance is needed for equivalent results. However, when operated well within ratings, good electrolytics serve quite satisfactorily, and are smaller and less costly. It is recommended strongly that an oil-filled unit be employed as the first capacitor in a power-supply filter (of the capacitor-input type) since the ripple is high at this point, and a high ripple voltage means a high current—a.c.—through the capacitor with a resulting reduction in life.

Capacitors used in power-supply filters preferably should be of the single-section type, to reduce the voltage gradient within the same case, although multi-section units always seem to work satisfactorily with different voltages on the sections. For cathode bypass use in audio circuits, the high-capacitance, low-voltage electrolytics are ideal.

Coupling capacitors are necessary in most amplifier circuits. The tubular molded types are compact and well suited for this use, for they are easy to mount and have no capacitance to the case. The grounded foil of tubular units should be connected to the plate of the preceding stage where the impedance is lower than usual in grid circuits, since there is less chance of hum pickup with this connection. Many designers prefer to employ metal-cased capacitors for coupling use. However, the capacitance to case must be considered, and while some types are satisfactory, others have too much capacitance for plate-to-grid coupling circuits, resulting in an attenuation of high frequencies. In shunt-fed transformer-coupled stages they are usable provided the capacitor is located in the ground leg of the circuit. The "bathtub" capacitor usually has a high capacitance to case; for coupling use the upright, oil-filled types such as Aerovox -16T or -18B, Sprague CNB, CNT, CAB, CAT, or General Electric styles 60, 62, 64, 66, and 68 have low capacitance to case, and are easy to mount and neat in appearance.

In most layouts, there is usually more space above the chassis than below, and the upright models with bottom terminals which extend through the chassis reduce the number of components under the chassis. These models provide complete shielding for the capacitors, and make for a professional-looking amplifier.

For filter and equalizer use, mica capacitors are most suitable. They do not normally have high voltage ratings, but in most instances there will be relatively low voltages across these units, so this should be no deterrence to their use. The use of ceramic capacitors for coupling purposes is not recommended because their insulation resistance is not as high as in the oil-filled or mica types.

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Shows the popular Patsy Lee with the TV 655. Note how swivel permits aiming at sound source without hiding face.

Shows TV 655 in the hand with swivel removed. Note how convenient it is to handle for announcing or interviewing.

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1000-volt capacitors is but little more than 400-volt types, the higher voltage ratings are preferred by the custom builder or experimenter for coupling use. In commercial production of electronic equipment, economics dictate the use of the lower-cost items, but the additional cost is of little importance to a person who is making but a single unit.

Resistors

For general use, the ordinary type of metallized or moulded resistor in the ½-, 1-, and 2-watt sizes are commonly used, and are completely satisfactory for most applications when used within their power ratings. It is good policy to allow a factor of safety of around 100 per cent for resistors in plate and cathode circuits. In standard sized assemblies, it is preferred to use 1- or 2-watt resistors for any application where there is a current flowing. Half-watt units are satisfactory for grid resistors or for tone correcting circuits. In low-level stages, some care must be exercised in the choice of plate-load resistors. Precision wire-wound types or the new deposited-carbon resistors (such as IRC type DCF) have lower noise level than most commonly used resistors, and are preferred for the input stage of amplifiers used for phonograph reproduction or with microphones.

When higher power must be dissipated in bleeder or voltage-dropping resistors, vitreous enamel wire-wound types are most satisfactory. They may be used almost up to their dissipation rating with a much lower factor of safety than usual in resistor selection.

Miscellaneous Components

The total number of component types is too great to be considered all in one article. However, some mention may be made of a few of them. Many different types of tube sockets are available, and their selection is of some importance. For general use, the socket which is mounted in a keyed hole by means of a wavy spring ring is most easily installed, but a special punch is required to prevent the socket from turning. Punches for these sockets are easy to use, the Pioneer Ham-R-Press being one of the most useful for chassis construction. The moulded-in-plate sockets are reliable and make good contact. For output stages, where the potentials across the socket may be quite high on peaks, ceramic sockets are desirable to reduce the possibility of flashover with attendant damage to transformers. For miniature tubes, the mica-filled sockets are preferred. Low-level stages should be cushion mounted to reduce microphonics, and several manufacturers make sockets which provide for such cushioning.

Electrolytic capacitors of the fabricated or etched plate type are commonly mounted on metal or Bakelite wafers. For lowest hum level in high-gain amplifiers, Bakelite wafers should be used, with separate leads connecting the shell of the capacitor to a common ground point.

Conclusion

The selection of other components will be discussed next month, along with an introduction to the layout of amplifier and power-supply chassis. While not as important as the actual electrical design of the equipment, the physical form of an amplifier often affects the performance, and as much care should be exercised in the mechanical layout as in the electrical design. For optimum results, each step must be carried out in the best possible manner to make sure of obtaining the desired performance in the finished product.

A New Technique for Reducing Distortion in Sound Recording

CALDWELL P. SMITH*

A NEW TECHNIQUE in recording was proposed by the author several weeks ago in conversations with associates in sound engineering, but the lack of suitable testing facilities delayed for a time the making of critical listening tests. Although comprehensive testing is not yet complete, the results have been so encouraging that presentation of the method at this time seems appropriate.

This technique is based on the fact that if a signal is passed through a network having phase distortion, and then reversed and again passed through the same network, the phase distortion produced by the network during the second transit will exactly subtract from the phase distortion produced during the first transit, and the net phase distortion will be zero. Obviously, some means of storing the signal and reversing it must be available, such as a magnetic tape recorder or a storage tube.

* *Cambridge Research Labs, 230 Albany St., Cambridge 38, Mass.*

By recording first on magnetic tape, then reversing the tape and cutting a disc or recording on film from the tape *running in reverse*, the disc or film can again be reversed for a final reproduction in correct time sequence, but possessing cleaner transients and resulting in a superior recording to a disc or film made by conventional techniques.

When a volume compressor is used, compression is applied to the *reversed* signal when played into the disc or film recorder. Improved compression characteristics are obtained, since the compressor has time to anticipate peaks, and much smoother action is obtained.

Part of the improvement resulting from the "reversed tape" technique is due to the phase properties previously described, for the phase distortion in the disc or film recorder and the phase distortion in the disc or film playback will subtract from each other, resulting in less net phase distortion in the final reproduction. Perhaps additional light can be shed by considering the typical transient in speech or music. The most typical signal is a damped sine wave building up rapidly to maximum amplitude and then decaying relatively slowly. When the recording is reversed, the oscillation builds up relatively slowly, affording time for the volume compressor to take control and presenting a much easier tracking problem to a cutting head.

One interesting development is the fact that one can produce a cleaner reproduction of a disc or from sound on film by reproducing it, played backwards onto a high quality tape system, and then reversing the tape for the final reproduction. The improvement will occur when the phase characteristic of the original recording system and the phase characteristic of the reproducer are similar, so that subtraction of the two phase characteristics will result in substantial improvement.

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- **Output Voltage:** approximately 25 volts open circuit. For matched resistive load, voltage varies less than ±0.25 db between 20 and 20,000 cycles.
- **Output Control:** calibrated from +25 to −25 db referred to 1 milliwatt into 600 ohms.
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KB-3A MICROPHONE

[*from page 17*]

microphone discriminates against a distant source in favor of a close source by values ranging from 6 db at 1000 cps to 30 db at 100 cps for the equal sound pressures at the microphone element. In addition, because of the directional pattern shown in *Fig.* 5, the discrimination against random noise is better than the above values by an additional 5 db. The net result is shown by the curve at (3) in *Fig.* 4.

Fortunately, the acoustic resistance

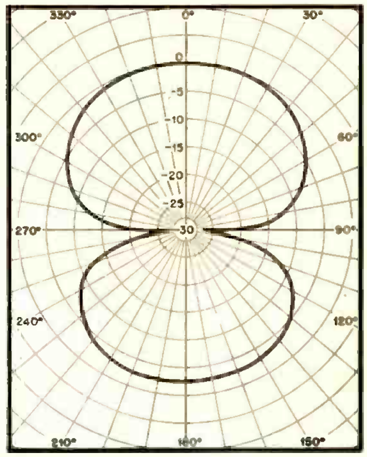
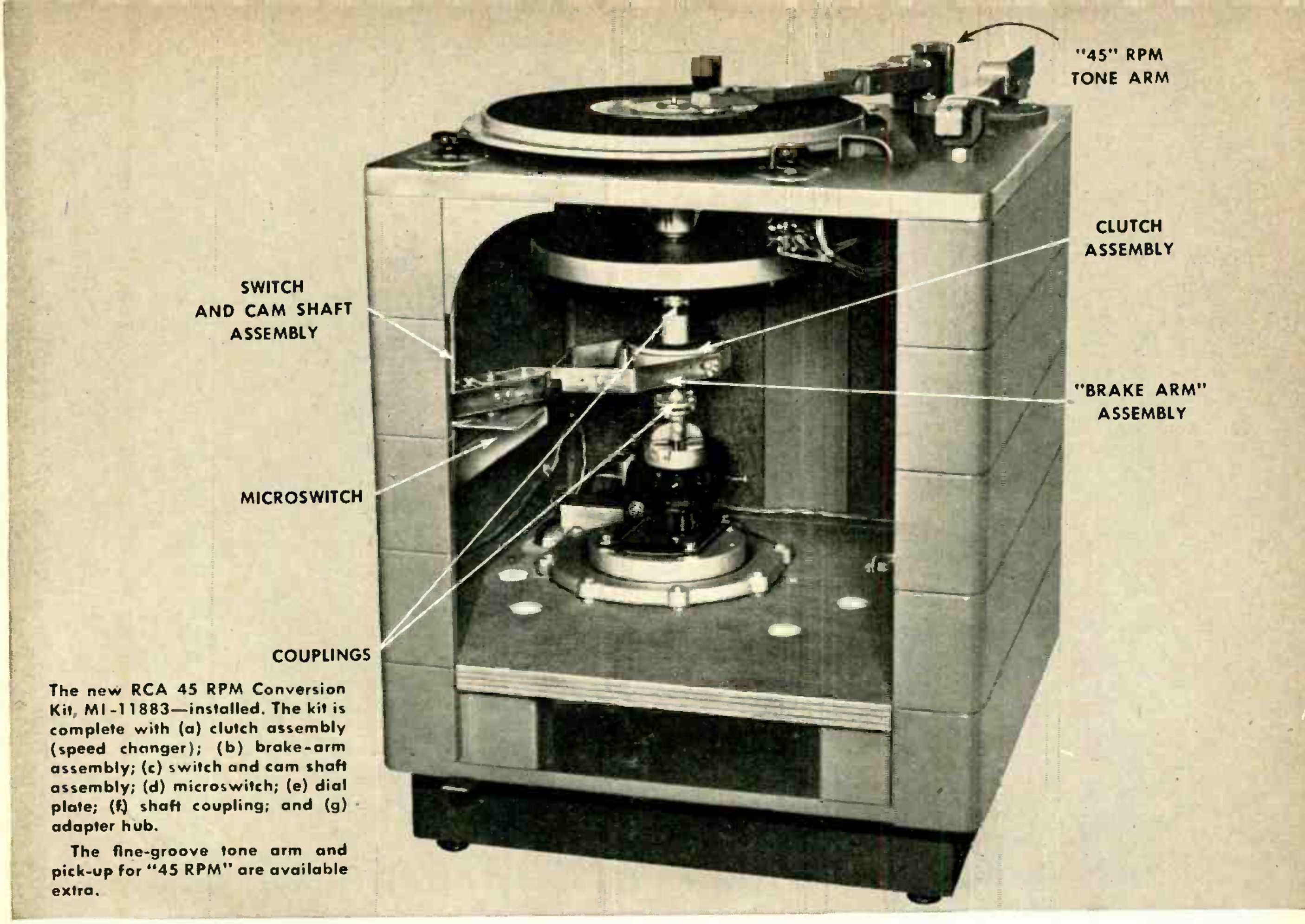


Fig. 5. Directional characteristics of KB-3A microphone.

added to secure the desired response results in a microphone which has less sensitivity to wind and breath puffs than is obtained with many diaphragm type pressure microphones. Further, the damping material serves as an excellent screen to keep foreign matter out of the moving system.

The output level from the microphone is high because of the efficiency of the generating element and the fact that the small size allows the speaker to get very close to it. In some cases it has been found desirable to introduce attenuation between the microphone and the preamplifier in order to prevent overloading of the amplifier with resulting distortion.

As can be seen from the data presented, we now have available for the first time a close-talking, high-fidelity microphone (RCA Type KB-3A) having a high output level and exceptionally good discrimination characteristics over a wide frequency range. One television broadcaster has successfully used the microphone on an audience participation program under conditions where usual microphones gave unsatisfactory performance because of acoustic feedback in an associated P.A. system. Its use in



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a ball park and a race track has resulted in higher acoustic gains than were formerly obtained with pressure microphones in sound booths of expensive construction. The KB-3A microphone was also used with success at a large technical society session where questions from the floor were transmitted to a speaker system from a portable microphone. Microphones commonly used resulted in feedback before adequate acoustic gain was obtained.

These are only a few of the possibilities, and this microphone should prove advantageous wherever a close-talking microphone can be used. The only restriction which need be remembered in extending the applications is that the microphone must be used at distances between 3/4 and 1 1/2 in. from the source of speech if the discrimination advantages and fidelity are to be fully realized.

GOLDEN EARS

[*from page 15*]

APPENDIX A

The tube manuals which indicate that several triodes can supply 100 volts or more push-pull into a resistive load are not in error; they merely start with theoretical assumptions which are difficult to satisfy in practice. For instance, they assume that the tubes and circuit will be well balanced. The only way to achieve sufficiently good balance is to match the resistors and capacitors, and though this is fairly simple when the required instruments are on hand, it is a complication which must be kept in mind.

More important, however, is the fact that with fixed bias 6B4's require an input resistance not greater than 50,000 ohms. It is possible that one or two types of tubes could produce 100 volts grid-to-grid into 50,000 ohms; but it would not be easy, and there would be no safety factor, because the stage would have to operate at its extreme limits. The cathode loaded type of driver is promising but is rather ticklish to adjust for best performance. Moreover, with the use of the cathode-loaded driver, the driving problem is merely pushed front-ward; appreciably more than 100 volts will have to be supplied to the drivers—not taking a feedbock loop into account—and it is no simpler to supply such a signal at this point than anywhere else. Also, it requires another pair of voltage drivers, and the additional cost of these brings the saving in money to very little.

The easiest and cheapest way to achieve high-fidelity performance is to build in a good safety factor. The critical driver stage is the place where a good safety factor is most desirable. A good transformer provides balance of one per cent or better, provides additional gain, and simplifies biasing. In short, it results in better performance and saves most of the headaches.

APPENDIX B

The trouble with phase inverters of the tube type is that they cannot be balanced dynamically. With two exceptions which we shall note in a moment, all phase inverters of the tube type are unbalanced in their frequency response. Those in which the second section obtains its voltage from the output of the first section are unbalanced at low frequencies because the second section obtains its input through two frequency discriminating networks, while the first section obtains its input through only one. Those in which the load is divided between plate and cathode are unbalanced at high frequencies because of differences in plate-to-ground and cathode-to-ground capacitances. The latter type, whose unbalance is preferable, suffers additionally from high heater to cathode leakage. Finally, being *RC* coupled devices, they are difficult to balance without the use of matched or precision resistors and capacitors. Those who may be skeptical of the importance of balance in *RC* coupled circuits are invited to make dis-

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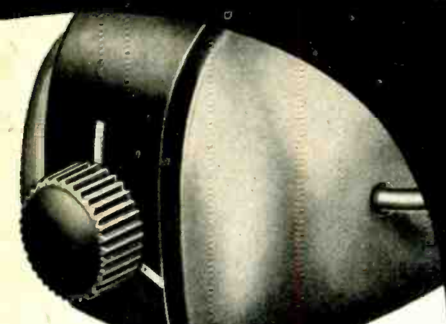

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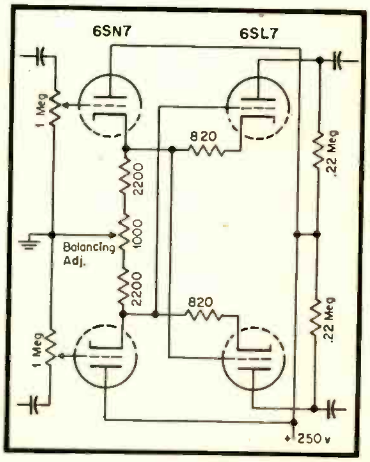
tortion measurements first on an amplifier in which one *RC* coupled push-pull stage is unbalanced by ten per cent. and then when the stage is balanced by matching resistors. These disadvantages may not be important enough in ordinary usage to outweigh the advantage of low cost. but in an amplifier for the Golden Ears—where even the best attainable performance falls short of perfection—the additional increments of distortion are too serious to tolerate.



Cross-coupled phase inverter.

The cathode-coupled inverter does not suffer any frequency unbalance if properly used. However, being an *RC* coupled device, it does require balancing or matching of components. Moreover, the heater-cathode voltage is high—about 70 volts. This can be corrected by applying negative bias available from the bias supply. but even so the residual unbalance is inferior to that of a good transformer.

The best of the phase inverters is the new cross-coupled circuit recently developed. It has no frequency unbalance except that due to differences in capacitance between individual tubes of the same type. It is very easily balanced and, being directly-coupled, has an excellent low-frequency response. It requires few resistors and no capacitors, and the resistors are easily matched. However, it requires two twin-triodes which consume more space than a transformer, and the cost is probably as great. Its one deficiency in our application was that the gain of 30 was not enough—without an additional amplifier—to provide the high input voltage made necessary by the feedback loop. So, in the end, we returned to the transformer and a voltage amplifier as the simplest and most satisfactory over-all solution to the phase inverter problem. Nevertheless, it is the best phase inverter we have tried, in many ways superior to a transformer. The circuit is given for those who would like to try it.

(See J. N. Van Scoyoc, "A Cross Coupled Input and Phase Inverter." Engineering edition of *Radio and Television News*, Nov. 1948.)

Note: The two inputs can be used to mix two input signals. If a dual potentiometer is used, a two-wire input (as a line or a high impedance pair from remote phono) can be connected grid-to-grid, and the circuit will provide complete cancellation of any hum pickup on the line.

HYGROMETRIC CHART

[*from page 24*]

and dry bulb type. Two matched thermometers are placed side by side. One has the bulb left exposed (the "dry bulb"), and the other has a tubular cotton wick over the bulb. The lower end of the cotton wick is kept wet by a reservoir of water, whence the name "wet bulb."

Ordinary hygrometric tables do not provide much data in the region of greatest interest, so a chart has been computed from U. S. Weather Bureau Psychro-

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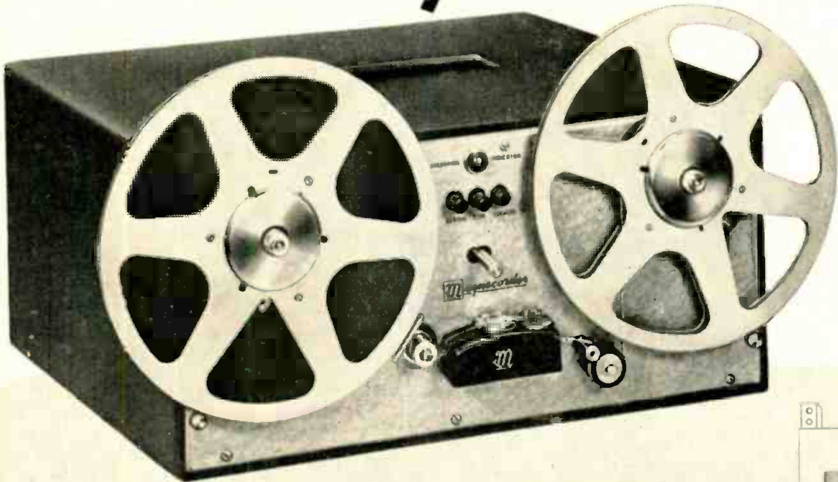

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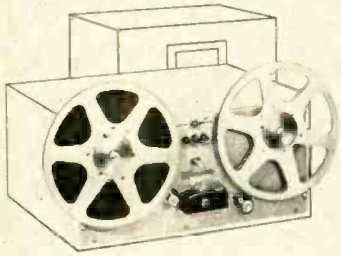
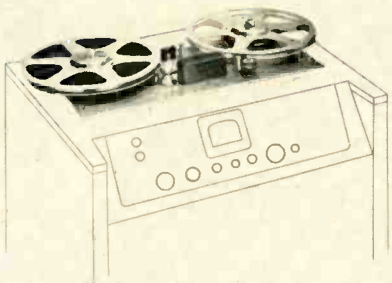
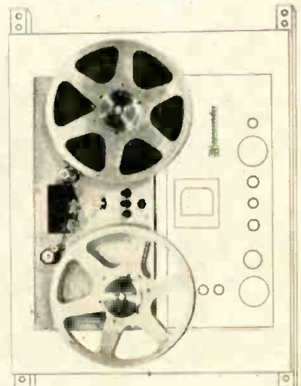


PORTABLE



CONSOLE



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metric Tables by C. C. Marvin, publication 235. To use it, subtract the wet bulb from the dry bulb thermometer reading. The chart will translate this difference reading directly into relative humidity. The graph was computed for a dry bulb temperature of 100° F. but may be used without significant error over the temperature range 90 to 110° F. in the high-humidity region.

A glance at the graph will show that 98 per cent relative humidity corresponds to a difference of only a little more than a half degree between the wet and dry bulb readings. To read this with any degree of certainty, expanded thermometer scales are necessary. It is very convenient to use long stem thermometers with the bulbs and most of the stems inside the test chamber, the scales alone remaining outside. They are regularly made with long scales covering a temperature range of only 10 to 12° F., and calibrated to one or two tenths of a degree. We have found the Eimer and Amend No. 13-575B to be convenient. This particular thermometer was made originally for Saybolt Viscosity tests, and covers the range from 94 to 108° F.

NEW LITERATURE

- **Precision Potentiometer.** A new instrument, employing a standard cell in combination with a potentiometer of 0.1 per cent accuracy, and permitting precise measurements of voltage is fully described in a brochure available from Southwestern Industrial Electronic Co., 2831 Post Oak Rd., Houston 19, Texas.
- **Cushioning Materials.** New 32-page catalog by Thomas Associates, 4607 Alger St., Los Angeles 39, Calif. gives brief specification data on a number of cushioning materials which meet Specs. AMS-3215 and SAE-SB-715. The complete line covers over 12,000 sizes and combinations of standard bare metal and cushioned line support clamps and blocks.
- **Antenaplex Systems.** A non-technical brochure, Form 2R-6301, describes RCA's Antenaplex system for apartment houses, hotels, department stores, institutions, and other multiple-unit structures where good television reception must be furnished from a single antenna system to a large number of receivers. This brochure is available from Sound Products Section of RCA Engineering Products Dept., Camden, N. J.
- **Magnetic Data Storage.** Storage of information for computing machines and other similar applications is described in a bulletin entitled "Magnetic Storage Systems" now being distributed by Engrg. Services and Sales Divison. Engineering Research Associates, Inc., 1902 W. Minnehaha Ave., St. Paul W 4, Minnesota.
- **Magnetic Tape Programs.** A new series of packaged educational recordings on magnetic tape has been announced. They include voices of 24 historically great personalities originally recorded on Edison cylinders in the years from 1888 to 1937, and including such names as Gladstone, P. T. Barnum, James Whitcomb Riley, Sir Arthur Conan Doyle, and Will Rogers. These programs are described fully in a bulletin available from Educational Services, 1702 K St., N. W., Washington, D. C.

Here's THE MAGNETIC TAPE *YOU* asked for!

Soundcraft wishes to thank the sound recording industry for its fine reaction to the Soundcraft magnetic tape quiz of January. Nearly 50% response testified that recording engineers are vitally interested in better tape.

Example #1: The quiz showed that most engineers prefer low-inertia plastic reels provided they will not warp or shatter. We, therefore, located and procured for Soundcraft tape new-type, multispoke, sturdy polystyrene reels that run true, stay true, and will not shatter from dropping or high speed rewind.

Example #2: Almost everyone complained about gumming of heads. Soundcraft tape was, therefore, engineered to have inherently low friction and homogeneity such that there is nothing to rub-off onto heads — simply *one* of twenty-odd fine features of Soundcraft tape.

Knowing the desires of recording men everywhere, Soundcraft was thus enabled to engineer and manufacture magnetic tape that, regardless of what superlatives may describe it, is *sure* to satisfy the greatest number of critical users.

Reeves Soundcraft tape is a new companion product to Reeves Soundcraft discs and styli.

"20 years with sound recording media."

Gentlemen: Date: NOW

Please send us OUR free sample of Soundcraft tape (200 ft. on 5" reel). We now use ________ brand and type # ________.

YOUR NAME ________

ADDRESS ________

← Mail—now—to

REEVES Soundcraft CORP.

35-54 36th STREET, LONG ISLAND CITY 6, N. Y.

EDWARD TATNALL CANBY*

Bow to the Right

THIS DEPARTMENT'S eyes have been sliding to the immediate right with some interest these months to welcome Uncle Rudo's comments. The remarks to the right of me on chamber music and jazz are to the point. Of course, jazz (not "name-band" stuff) is chamber music, if we must use that slightly nauseous word; nor would any reasonably tolerant musician deny it for a moment. If you replace "chamber" with its proper modern term "room," you have *room-music*, as opposed to *hall-music;* close-up music as opposed to distant music. Jazz or classical, it's all the same.

But what most intrigues me in Uncle R's discussion is the relation between "live" jazz and recorded. As for classical chamber music, sometimes a really good recording can give a breathless sense of presence, plenty adequate for any purposes of musical enjoyment. Jazz, perhaps, is different, in that it is by nature unpredictable, and it's hard to be unpredictable more than once on a record! The unpredictable elements in the classical performance are similar, but perhaps more subtle—the notes are fixed, but not the interpretation, which may soar or fall flat in a thousand ways during the live performance. The performer's personality is not as important in good chamber music, for interpretation is somewhat different from composition; interpretation is great when the artist somehow becomes a kind of transparent medium through which the original composer seems to be speaking directly. Not so in jazz, where the original composer has provided mostly a framework of tune and harmony to hold together individual improvisation.

But on to Mr. Globus' March discussion, if I may. When it comes to reproduced listening for most common types of popular music, we might as well, as he suggests, give up looking for the "original" live performance because there ain't no sech thing! We never hear a popular vocalist, for instance, minus some form of mike, whether broadcast, P.A., or recording mike. How many of us have heard Frankie's *actual* voice, in the original? Bing's? More than this, there are a number of popular band instruments that depend entirely on electronically reproduced sound for their function in popular music—the electric guitar, for example. This instrument can play with perfect equality against a trumpet which, in the natural state of things, would be a more powerful sound source than several hundred guitars together. And this, of course, not only in the broadcast and recorded performances but in so-called "live" performances as well. Indeed, the whole over-all balance of the large popular band-plus-vocalist is permanently determined by electronics and the writing of musical scores (arrangements) for these orchestras now automatically takes for granted the electronic kind of sound. When you come down to it, only the demands of musical comedy—which for practical reasons is given mikeless in the theatre—keep popular music from the all-electronic category. (A stage performer is still pretty much impossible to pick up selectively; musical comedy singers must depend on their own natural powers of amplification.)

"Lincoln Portrait"

The progress that popular music has made in what we might call electronic instrumentation, based on volume balances achieved via amplification, is most important to all music—otherwise I'd have no business talking about it. But the interesting thing is that it is only beginning to be deliberately, intentionally used in scoring music outside of the popular field, for no very good reason other than traditional conservatism. Many composers are now rather cleverly writing music that works well both ways—take the Menotti operas, "The Telephone" and "The Medium," which are fine on the stage, but are really just as adaptable to radio and recording balance with mikes. The only specific dependence on real electronic balance that I can think of in "classical" music is a group of works recently composed with a speaking narrator plus full orchestra—for example, Aaron Copland's "Lincoln Portrait." A single speaking voice can be heard properly against a large orchestra (even pianissimo), only when it is amplified, and this work was quite clearly intended for a radio-style

[*Continued on page 49*]

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

Pops

RUDO S. GLOBUS*

Recording Criteria—Part 2:

LAST MONTH saw the first descent into the "lower regions" of pop recording. Now to analyze our findings and come to some sort of workable decision. As should have been apparent, there are fundamentally no criteria in terms of sound which are objectively definable with relation to pops. The notable exception is jazz, of course. Therefore, inasmuch as the "jazz problem" has been fulsomely covered in past articles, we will concern ourselves here with only the general pop problem.

What is most impressive is the total artificiality of the situation. More poetically, we are dealing with an artificiality within an artificiality. There is no longer any contact with reality, whatever that is. The unfortunate engineer is ultimately expendable in this situation, for his is but to do or disc, not to take the nasty risk. Back to classical and all its more elevated and precocious responsibilities for some clue as to the situation:

What determines the broader aspects of a classical recording in terms of sound coloration, acoustical conditions, dynamic expansion, and so on? The tragedy of this piece involves the fact that all the above mentioned factors are sealed into a recording. The gadgeteers will howl about what can be done with expanders, resonators, undsoweiter. Let's not be silly. What can be done is ultimately too insignificant compared to the total so that one immediately thinks of utilizing a can opener to lift the sounding board of a poorly recorded piano. Therefore . . . given certain possibilities available to the recording engineers involved, there is the conspiracy of musical director, conductor or soloist, public taste, etc., to be reckoned with. From the 1930's on, taste became a force to be reckoned with. I am not referring to the foliating buds spread evenly across the tongue; the ear and its attachment to thousands if not millions

* *960 Park Ave., New York 28, N. Y.*

of accumulated "sound prejudices" is our baby. This mechanism accounts for some of the atrocities it has been our pleasure to witness for many years. In 1931, '32. '33, '34, '35, '36 the predominant taste situation called for live, live, live, brilliant, brilliant, brilliant. This was the period of Columbia's foreign recordings of the Beethoven Ninth, etc. But . . . around 1937 and '38 the fickle ear did a turnabout (an unseemly metaphor), and the demand arose for dead, dead, dead, no resonance, no brilliance, etc. True, the engineers were involved in this monstrous chain of events. But they could never have gotten away with it if it hadn't been for lugs like you and me and the musical ones who call themselves conductors, soloists, musical directors, etc. No need to go into the changeabout of more recent times.

Ultimately, to make this thing as short as possible, you and you alone know how you want to hear music. Your opportunities for developing a realistic and precise taste are more limited than may appear on the surface. Even concert halls have their specific acoustical conditions. The possibilities for variations in sound production are enormous and complex. Everything from atmospheric conditions to seating arrangements plays a part. You yourself are never the same kind of sound receptor twice in a row. By this I do not refer to accumulated ear wax or the hanging of your hair over your ears. I am concerned with mood, general temperament, the baffling factor of sound memory, and even the predisposition to anticipate your "type of hearing."

Now apply this to the pop situation. We pointed out last month that your entire range of pop listening is artificial. Everywhere and anywhere a sound system is involved. Now the individual problem is a totally indirect one. How do you want to hear pop music reproduced? With the exception of jazz, you might as well make your basic criterion recorded pops, for the obvious reason already indicated. Popular music is electronic music under all conditions and all settings. Should it all be recorded the same way or are there certain possible variations?

This is the meaning of the above used phrase "an artificiality within an artificiality." For example, Decca has recently released two singles on which Artie Shaw and his Grammercy Five as well as full band perform rather dully and poorly. A local disc jockey premiered them in this town and made some rather impertinent concluding remarks about these tiresome discs. His theory was that Decca had gone Hi-Fi and this sophisticated and high-class switchover has ruined what would have been something terrific under the previous hoi-polloi conditions. He squirmed around the Hi-Fi business for a while, admitting a sentimental fondness for clothes closet techniques characteristic of the past. But . . . the crux of the matter and the important point came after stumbling around the metaphysics of Hi-Fi for a while. Genius disc jockey maintained that Hi-Fi made the orchestra sound "like it really should have on accounta it make instruments sound like they really should, seeeee!" Soup-can technique, however, gave the orchestra a nice warm sound . . . rich, firm, and fully plucked. Dear friends . . . this one was quite serious and is merely reiterating a general point of view. Is he wrong? No! Not in the least. Within the increased range of possibilities, he has made his decision. Every grown boy and girl must also make a decision as to how they want to hear music. Where does the engineer come in? In the final analysis, he does not and should not. His function is to record as he is told to record.

And here is the only tangible and realistic criterion we have for making final judgment. Is the final product exactly what was intended? We may vigorously and violently disagree with what was intended, but must admit that this is ultimately an individual, non-objective situation. Where the engineer determines the intention of a given recording, he is fully responsible. In most cases he doesn't. Therefore we attack or approve of the taste and discernment of the individual or individuals who have determined how a recording of a given work should sound. Who is to determine which approach is right and which is wrong? The only available test at the moment is the eternal dollar. Actually that isn't even a test, because the publicity drums and the local disc monster can even convince the most tone deaf rodent in the area of choice.

Therefore, the function of the record critic (and every buyer of records must be to some extent a record critic) is to determine as closely as possible what his "personal taste" is and then recognize that it has no more validity than anyone else's. His second, and probably most important, function is to indicate whether the individual recording represents a faithful and adequate job in terms of what has been ordered for the specific recording. I have purposely avoided mentioning the ultimately major factor . . . the musical question. This can be taken care of some other time (and prepare for a seething attack on the musical qualities of present day pop music). Next month an analysis of adequate and inadequate, efficient and inefficient pop recording techniques.

LATEST RELEASES:

In order to justify what appears above and to make it contemporaneous with the every day problems of today, this section of the column this month will be concerned with two recent releases, both of which are good examples of theory applied. A preliminary statement is necessary. One of the recordings to be reviewed will go unnamed (in this connection) for purely personal reasons. Though I would risk friendship, my life, my future, and my income for the sake of truth, etc., there is no sense making my life uncomfortable for the next few months. The recording was made by a friend, and what happened is not his fault. Sometime within the next few months I will re-review it, without pointing out that it was referred to here. Meanwhile, if you happen to guess correctly, I'm not responsible. I will not even mention the name or the record company or the type of recording (LP or otherwise) for fear that the hawk-eyed readers of Æ will spot the culprit too easily.

Mystery Recording No. 1
Foolish and Inadequate Inc.

This baby is an orchestral recording which is entirely too unhappy and really shouldn't have been. The music is good and the instrumentalists were the best available (on the level). I was present at the recording session and therefore can practice what I preach in this case. There were about forty men involved and a fair-to-middling soloist. The studio was one of the best. We liked the sounds we heard during rehearsal, and to all intents and purposes the finished product should have been one of the best, on a par with the engineering talent available for this session.

But . . . extraordinary things began happening. The soloist was separated from the orchestra and given his own mike. This seemed logical because the first test indicated some weakness and a rather bad balance. It was then decided that the horns should be given their own mike, the woodwinds their own mike, the percussion section their own mike, the brass their own mike, and so on, ad-infinitum. For a moment it seemer that spring was here and mikes were popping out of the ground like fresh June radishes. Now there were almost as many mikes as instrumentalists and as many engineers chasing around for more mikes as would be required for a dozen recordings.

Ten more tests altogether, each one resulting in this or that change in mike placement, and so on. Final test playback sounded all right, so it was passed. Your eager critic was rather confused by all this, since it occurred to him that the final playback, using a whole army of mikes, had resulted in no improvement whatsoever. Came a day several weeks ago and a chance to hear the final product via a review copy. Sheer midsummer madness. The orchestra was cut way down, the soloist built up to the point where his booming rich sounds had all the delicacy of an intoxicated foghorn. What happened to the pressing itself is rather interesting. Crummy surface, poor tracking, interesting off-center pressing effects, etc.

A crime . . . a vicious, nasty crime. Good music, good performance, and even good original intentions *à la* how the date should be recorded. But bad, bad, bad engineering. The utilization of multiple mikes had only resulted in a cutting down on the mikes covering the orchestra section and a concomitant building up of the soloists' mike. This is no time to go into the advantages of single versus multiple mike set-ups, but if there is any rationale to multiple mike usage, here is a perfect case of its disadvantages. The ineptitude of the engineering staff on this occasion is patently obvious, (although the producer or musical director usually determines the number of microphones). I can guarantee that the final product is definitely not what was intended.

Therefore, I have no choice but to knock this baby and knock it hard. Despite the fact that it is musically interesting and was well performed "live," the final product is not acceptable. As promised, this baby will be reviewed under its real, true to life name, sometime within the next few months. Draw your own conclusions then.

Creole Love Call **Columbia 1-369**

Duke Ellington and Orch. Vocal by Kay Davis

This is a honey, a joy, a problem. We have been unhappy and insecure about Ellington's recent history. There is something tired and commercially flip about the stuff that's come out during the last five years. This is musically so-so. Its only interest lies in the instrumental use of the vocal, which is moaned in a pretty falsetto by one Kay Davis.

But what a rip-roaring recording. Before we go all out for it, may we point out that it is a Columbia 7-inch LP. There has been a controversy raging about these babies, and rightly so. The first group of releases on the 7-inchers were pretty punk. This is a tremendous recording. Made in a large, live studio, it is almost frighteningly live. Why hold back . . . it is one of the greatest technical jobs of pop recording that these tired old ears have ever heard. Fortunately, and wisely, it is a short record. The danger zone is barely entered so that it is good till the last drop.

But . . . one problem. This baby is over recorded. It sounds perfectly magnificient so long as good magnetic pick-up is available. With crystal . . . the usual over-recordedosis. Heavy blasting, distortion, etc. This gives rise to the old controversy as to whether records should be made to sound magnificient on magnetics alone or should sound good under any or all standard conditions . . . in other words, the over-recorded disc problem. But leave this for some other time. What is important here is that the engineers got exactly what they were told to get onto this little baby. I heartily recommend it as a demonstration piece.

You of All People **Columbia 1-369**
Duke Ellington and Orch. Vocal by Al Hibbler

This is the other side of the little gem above. It has all the magnificence of its other face but should be dealt with in terms of its utter banality. This is poor, poor Ellington. As a standard pop, it might get by. But as the production of the agile and inventive Mr. Ellington, it is tired, banal, meaningless guff. Even the orchestra, magnificently revealed by the quality of this recording, sounds tired. And sounding tired in a live recording of this sort is a hard job.

Pot Luck:

Just a word about our enthusiastic outburst last month on the jazz revival pitch. I was cautious and fortunately so. I mentioned that the big push by Jimmy Dorsey et al might be an extreme manifestation of the music business to stir up some excitement on the novelty level. The possibility is a reality. The big bozos are no more interested in reviving jazz legitimately than . . . ho hum. The usual business. The switch is already occurring. Someone has recently whispered into these pearly ears that the newest thing will be a revival of gypsy music with vocals and 4-4 beat, no less. Gad, are we in a rut!

MAGNETIC RECORDING

[*from page 20*]

noise ratio, for which no term has as yet been coined, concerns the ratio of the maximum signal to the noise-behind-the signal, the noise being a function of the signal strength. This latter type of noise (often termed modulation noise), while readily visible on an oscilloscope screen as a crest-distorted wave when a pure sine signal is recorded, is less easily measured, although sharply tuned band rejection filters have been employed for the purpose.[3, 4]

Noise in magnetic recording may be due to one or a number of the following factors:

1. Non-uniformity in the ferric oxide dispersion of the magnetic layer on the film. This type of noise is usually spoken of as the "ground-noise" of the magnetic medium.
2. Incomplete erasure of a previous signal on the film.
3. Unsymmetrical wave shape of bias current.
4. D.c. magnetization of head, guide-roller, spool, etc. Anyone experienced with magnetic recording operations knows that considerable effort must

[3] S. J. Begun, *"Magnetic Recording,"* New York: Murray Hill Books, Inc., 1949; p. 214.

[4] S. J. Begun, "Measuring Procedures for Magnetic Recording," AUDIO ENGINEERING, April, 1949, p. 19.

sometimes be exerted to produce quiet recordings. The writer's tools—screwdriver, pliers, even the shears for cutting the magnetic film—are made of non-magnetic 18–8 stainless steel. It is also a good policy to demagnetize recorder parts frequently with a demagnetizing coil which may be energized directly from the common 110 v. 50 or 60 cps current supply.

5. "Print-through" or "echo" effect, when magnetization on one part of the film on a roll is transferred to an adjacent layer. This effect is more pronounced in the presence of a strong alternating field and at high temperatures.
6. Clicks and pops due to improper splicing.
7. Modulation noise. This type of noise is a function of the signal strength.
8. Variations in contact between medium and heads.
9. Variations in cross-section of soundtrack, scratches, etc.
10. The presence of foreign particles in the head gaps.

APPENDIX I

It is sometimes desired to know what the diameter of a roll of film or tape will be when a certain length of film is wound on a core of a given diameter. Conversely, one may wish to know how many feet of film a roll contains when its diameter and the core diameter are known. The formulae are:

$$D = t + \sqrt{(d-t)^2 + \frac{4tl}{\pi}}$$

$$l = \frac{[(D-t)^2 - (d-t)^2]\pi}{4t}$$

where D = diameter of roll of film, inches
t = thickness of film, inches
d = diameter of core, inches
l = length of film, inches

For instance, when 400 feet of .006″ thick film are wound on a 2″ core, the diameter of the roll will be

$$D = .006 + \sqrt{(2-.006 + \frac{4 \times .006 \times 400 \times 12}{3.14}}$$
$= 6.37$ inches

FLETCHER-MUNSON

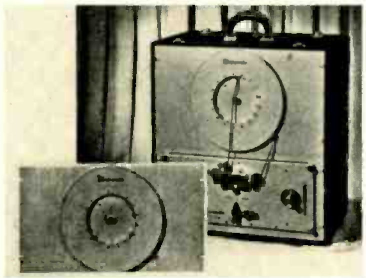
[*from page 23*]

of 1000 ohms and comparing each step until the most pleasing effect was obtained. When the optimum setting was established it was not changed again. Even at low listening levels the bass in symphonic music was still quite full, and at all levels the bass was realistic. This effect was obtained without the loss of highs. Speech remained sharp, rich, and natural; muscial instruments did not lose timbre.

These tests confirmed that compensation for the Fletcher-Munson effect is a necessity for realistic home listening, and that such compensation should be flexible and rather large in amount.

NEW PRODUCTS

● **Continuous Loop Device.** For those applications which require the repetition of a segment of program material recorded on magnetic tape, the new Magnecord PT6-EL Continuous Loop Panel permits the playing of endless loops ranging



in playing time from 2 seconds to 15 minutes. The PT6-EL will hold up to 600 feet of standard tape, and can be rack-mounted, or is available as a portable unit. The tape feeds onto the outside of a stationary storage reel, winds inside, and then feeds out the center to the normal tape path of the recorder.

The PT6-EL is finished in a gray hammerloid tone which matches existing Magnecord equipment.

● **8-Watt Amplifier.** A new, low-power amplifier which provides a quality signal for inexpensive home installations is just announced by The Minnesota Electronics Corp., 97 E. Fifth St., St. Paul 1, Minn. The Goodell "50" has continuously variable bass and treble tone controls, and is designed for use with a plug-in preamplifier for reproduction from magnetic pickups. The amplifier employs two 6L6's

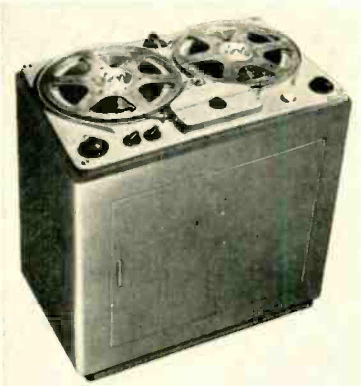
with stabilized degenerative feedback, and offers output impedances of 4, 8, 20, 250, and 500 ohms. An input selector switch permits choice of source signals from radio and phonograph, positions being provided for both standard and LP records, with built-in equalization. Output power is 8 watts at 2 per cent harmonic distortion.

The new "50" rounds out the Goodell line which also includes the NSA-20 rated at 10 watts, and the AB-3 and ATB-3 rated at 16 watts. Further information may be obtained from the manufacturer.

● **Breath Blast Filter.** Undesired "pops" due to breath blasts and wind noise encountered in outside pickups is effectively eliminated by the use of the new Electro-Voice Model 335 Blast Filter, designed to

be used with E-V 630, 635, and 650 moving-coil microphones. The grille of the filter is curved to give optimum filter action without affecting the normal frequency response of the microphones with which it is used, and aids broadcasters and public-address operators in both studio and field pickups. For full details, write for Bulletin 86, available from Electro-Voice, Inc., Buchanan, Mich.

● **New Tape Recorder.** Featuring operational and performance qualities found only in the most expensive studio equipment, the new Berlant Concertone line of magnetic tape recorders is available at a price formerly asked for popular home-type equipment. The unit is available as

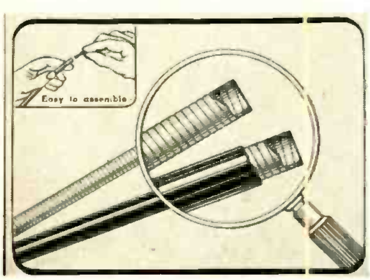


a basic model which consists of a cast aluminum chassis 14" by 22" which carries the tape mechanism and the dual-track heads. The amplifiers and the power supply are contained on a separate shock-mounted chassis. The addition of a custom case converts the recorder to a complete portable unit, and a console cabinet —as shown—makes a complete unit suitable for studio use. Complete information can be obtained from Berlant Associates, 9215 Venice Blvd., Los Angeles 34, Calif.

● **Garrard Changer.** A completely automatic three-speed record changer, the Garrard "Triumph" model RC-80, was recently shown at the IRE Show in New York. This model is unique in its use of interchangeable spindles—one of the standard type for 78's and LP's, and a wide center-drop spindle for the 45's. It is designed to accommodate most conventional types of pickups. and the tone

arm is jewel mounted and provides true tangent tracking. Speed is remarkably free from effect of line voltage variations, loading, or whether first turned on or operated continuously. The turntable is heavily weighted to give flywheel action. For further information, write to Garrard Sales Corporation, 164 Duane St., New York 13. N. Y.

● **Monocoil Wire Shielding.** A new type of shielding which is especially desirable in chassis construction has been announced by Kupfrian Manufacturing Co., 245 Prospect Ave., Binghamton, N. Y. This material consists of a helically-wound, flat-wire shield, which may be



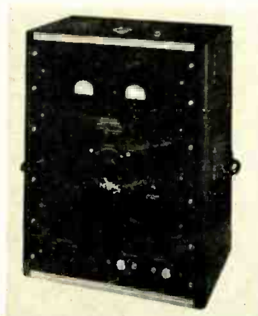
used with any type of conductor desired. For applications requiring insulation over the shield, a vinyl cover has been added, making a flexible lead which may be had in various colors for coding. The shielding may be had in tinned brass, tinned steel, and a special bronze variety which has the advantages of the strength of brass with the lower cost of copper. Complete information may be had from the manufacturer.

● **Stylus Resharpener.** Said to repair all types of jewel or metallic cutting styli, a new sharpener is now available for use by recording studios and radio stations which do their own recording. This device actually cleans the tiny facets of the stylus and completely removes all traces of aluminum from the tip, thus eliminating hisses, squeals. and other undesirable noises occasioned by cutting too deeply. This device is the first product of Strandberg Recording Company, 705 Woodland Dr., Greensboro, N. C.

● **High-Voltage Connectors.** A line of six models of connectors designed for use with pre-amplifiers operating at moderately high voltages has been announced by the Atomic Instrument Co., 160 Charles St., Boston, Mass. These multi-circuit connectors have an insert body molded from melamine for high dielectric strength, and are keyed to provide positive polarization. Also available for use with these connectors is a special six-conductor cable consisting of three separately shielded leads, a coaxial cable, and two unshielded leads. This cable is

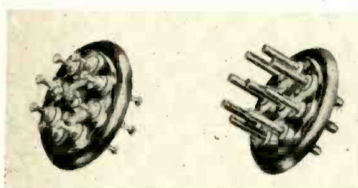
double shielded over-all, and jacketed with .060" neoprene, with an over-all diameter of approximately one-half inch. Detailed specifications may be had from the manufacturer.

● **Power Supplies.** A wide variety of regulated power supplies is available from Furst Electronics, 12 S. Jefferson St., Chicago 6, Ill., with output voltages ranging from 50 to 1000 volts at current drains from 0 to 500 ma. The unit shown is a 500-watt model, but others are stocked with ranges from 1.5 to 150 watts.



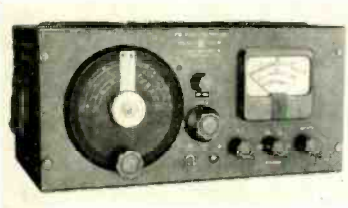
Source impedances range from approximately 2.5 to 15 ohms in most models, and ripple voltage is below 20 mv in all models. A brochure describing nine models is available on request to the manufacturer.

● **Hermetically Sealed Terminals.** Meeting all classes of JAN-T-27 specifications, the terminals shown consist of a trifluorochloroethylene thermoplastic resin body, with the terminals molded in. Operating potentials at sea level reach 3000 volts



peak, and current rating is 15 amps. These terminals are made in both standard and special designs with three to nine leads. Inquiries are invited by the manufacturer, Molding Corp., of America, 58 Weybossett St., Providence, R. I.

● **FM Modulation Monitor.** Measurement of frequency departure of FM emergency services transmitters is simplified by use of the new Model MD-25 Modulation Monitor, just announced by Browning Laboratories, Inc., Winchester, Mass. This instrument is designed for the ranges from 30 to 50 mc, 72 to 76 mc, and 152 to 162 mc in four bands, and makes it possible for one unit to be used in checking transmitters on widely separated frequencies or on different bands. Both coarse and fine tuning controls are provided, enabling the engineer to make precise adjustments of the instrument to match the carrier frequency. Upward or downward swings up to 20 kc can be measured with an accuracy of better than one kc, using an easily read 4-in. meter. The audio output permits use of the



monitor for aural or visual checks, using a loudspeaker or an oscilloscope. The sensitivity of the instrument is sufficiently high that less than one mv is required on the antenna terminals for complete measurement. Complete information may be had from the manufacturer.

● **Continuous Playback Machine.** Where it is necessary to provide a continuous program of high-quality music or voice, the newly announced Ampex Model 450 will serve as a compact, reliable unit. This model is designed to use a twin-track magnetic tape of one-hour duration in each direction, and the use of Ampex heads ensures the highest quality from this type of program material. After playing for one hour, the machine automatically reverses by means of a special

thyratron circuit, and the second track is played in the other direction, using a separate playback head. It may be pre-set to play for two hours and stop, or it will play continuously, as desired. The tape speed is 7½ in./sec., and frequency response is within ± 2 db from 50 to 10,000 cps, ± 3 db from 30 to 12,000 cps, with less than one per cent harmonic distortion at an output level of ± 17 dbm. Complete information on the Model 450 may be obtained by writing Ampex Electric Corp., San Carlos, Calif.

● **Tweeter Adapter.** Designed for converting a dual speaker to a three-way system, or for making a full two-way speaker from a conventional driver, the new Stephens Hy-Son Model 107 Super-High-Frequency Reproducer system covers the range from 3500 to 20,000 cps. This unit is only 7 in. deep over all, and is sold complete with dividing network. Due to the small mass of the moving system, together with a carefully designed throat configuration, very low distortion is claimed. The unit is simply connected across the high-frequency speaker of a two-way system, or across the input to a conventional speaker. The input impedance is 16 ohms, and the frequency response is flat within ± 3 db up to 15,000 cps. Complete specifications and prices are contained in Bulletin 107, which may be had by writing Stephens Mfg. Corp., 8538 Warner Drive, Culver City, California.

● **New Knight Recorder.** Featuring a long playing time and ease of operation, the new magnetic tape recorder recently announced by Allied Radio Corp. is especially suited for use in business and industry. Simplified tape threading eliminates fumbling, and only one control is required to operate the tape transport mechanism—Record-Play, Off, and Rewind. Recording speed is 7½ in./sec., and the rewind speed is twenty times as fast, another unusual feature in a moderately

priced unit. A neon bulb indicator ensures proper recording level, using microphone or radio tuner for input. A speaker is built in for convenience, but external speakers may be used if desired. For full details, write to Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

● **Variable Transformers.** For laboratory and testing use, it is often necessary to furnish a source of a.c. voltage which is controllable over a wide range. The Powerstat Model 116 recently announced provides a range of voltages from 0 to 135 volts when used with a 115-volt source, while the Model 216 provides a

range from 0 to 270 volts when used on a 230-volt line. Both are designed for use on single-phase, 50/60 cps lines, with Model 116 being rated at 7.5 amps, Model 216 at 3.0 amps. A wide variety of styles is available to suit differing requirements, and full information may be obtained from The Superior Electric Co., Hannon Ave., Bristol, Conn.

Book Review

Acoustical Designing in Architecture, by Vern O. Knudsen, Ph.D., Professor of Physics and Dean of the Graduate Division, University of California at Los Angeles; and Cyril M. Harris, Ph.D. Member of the Technical Staff, Bell Telephone Laboratories, Murray Hill, New Jersey. 457 pages. New York: John Wiley & Sons, Inc., $7.50.

For audio engineers as well as architects, this book fills the long standing speculative gap in the collected knowledge of architectural acoustics. Carefully assembled in the first fourteen chapters are the fundamental principles and methods of good practice for the acoustical design of all types of buildings. The last six chapters are devoted to specific applications of the earlier material. No outline by chapter or section can cover the diversity of useful material presented.

The presentation is clear, and having been written for the design architect as well as the engineer, many charts, tables, and monographs have been included for ease in computation rather than mathematical analyses. However, there are frequent references to more detailed mathematics and engineering articles for those desiring further information.

The make-up of the book—including paper, layout, type, and illustrations—merits notice, since it contributes greatly to the over-all usefulness of this volume. It is recommended for architects, plant and building engineers, audio engineers, and students as a valuable guide to the design and acoustical correction of buildings, and as an aid in the design and installation of auxiliary equipment, such as sound systems, heating and ventilating machinery, hoists, and elevators. As the authors point out, attention to the acoustical design of these equipments can prevent them from becoming noise annoyances.

RECORD REVUE

[*from page 38*]

balance between the voice and the music. Even so, "Lincoln Portrait" was given some years ago in Carnegie Hall by the Boston Symphony, solid bastion of traditionalism, and there were *no* mikes. ('Twouldn't do to have one of those new fangled gadgets at a serious concert, I suppose.) The narrator practically split a gut, to be rather literal and yet from my seat, which wasn't a bad one, not a word in twenty was intelligible. How would *you* like to recite the Gettysburg Address to some thousands of people and have to out-shout a major symphony orchestra in the process!

If you want to hear how "Lincoln Portrait" was intended to sound, listen to the *recordings* of it. There, you see, the balance is as the composer intended and calculated. Just as in popular music, there can be no "live" performance of this work in the sense of no-mike, no-amplification.

Amplifying Older Music

But such cases are few and far between. The biggest problems along these lines come with the necessary recording, broadcasting and amplification of music that definitely was never intended for it. And the most extraordinary misunderstanding and miscalculations can happen here. Take, for an interesting physical example of what we get into, the harpsichord-plus orchestra combination—not because I wish to foist that instrument on you, though it's one of my pet likes, but because its proper reproduction is an extremely interesting problem, and typical.

The harpsichord is not unlike the guitar, technically. It has a small sound, volume-wise, but its musical effect packs a considerable wallop. Moreover, when *heard* at reasonable loudness, its tone is huge, impressive, more orchestral-sounding than even the piano at its biggest. (I mean when the volume level *at the ear* is properly high.) In the time of Bach and Handel, when the biggest harpsichord concertos were written, concert-giving was altogether different than now. Music was played not for large public audiences in huge halls, but for groups of invited guests, anywhere from a dozen to perhaps a half-hundred or more. (If you entertained 50 guests in your house, you'd feel you were putting on a pretty big show. Think of it that way.)

In any private establishment, even a king's palace, seven or eight instruments can make a lot of noise. For the concertos of Bach's day the instrumental group often grew as large as thirty or so. (Again, think of 30 instrumentalists jammed into the drawing room of the largest house in your town. Quite an awesome array and a lot of sound, too.) Now the harpsichord, the big one of that day, with four sets of strings and intricate gearshifts to switch them and couple them together, was an impressive affair in such circumstances. Obviously, it could be heard and heard well. Common sense will tell you that it wouldn't have been composed for if it hadn't been effective. People wrote music to be played, in those days, and usually played within days or hours after it was written, too. A Bach or Handel harpsichord concerto, or equivalent (in the thousands), performed as written, in its intended surroundings, was a mighty and impressive piece of music and the harpsichord was no dainty, fragile thing but a lordly and commanding instrumental voice. You can read that "between the lines" in the kind of music written for it. It's not apologetic music.

Lost in the Concert Hall

Today? In the modern concert hall the harpsichord, lost in huge volumes of empty space, flanked by a grossly swollen orchestra ten times the proper volume, suffers an extreme laryngitis. All you hear, if anything, is a faint, distant, tinkle, the higher overtones of the strings, which penetrate through the lower sounds like a fine scalpel. Nice effect. But not what the composer intended! Amplification? Classical music, at least in concert form, is a conservative business. It seems that most harpsichordists would rather go unheard than be amplified. Silly, but only the truth. (It's partly the sound man's fault, for doing a few notoriously bad jobs that have scared the musicians away from what should be sound reinforcement, not straight P.A.) When Landowska performs in Carnegie Hall, the audience sits on pins and needles, holds its breath, and hears practically nothing. And—worst of all—they simply rave over the beautiful, etherial, delicate sound! Phooey. But you can't entirely blame them—after all, they may never have heard a harpsichord in any other situation but this wrong one.

And so we come to recording of the harpsichord-plus-orchestra. Aha! Now, you see, the "original" can be restored. With intelligent microphoning, a Bach harpsichord concerto can be made to sound, for once, very much as it did to Bach's contemporaries. Without any doubt the electronic treatment has had much to do with the extraordinary come-back of this instrument in the last twenty years, after more than a century of total disuse. (Incidentally, of course the harpsichord has been the object of some fine and furry snobbery. Anything of the sort is likely to attract the musical drones, so to speak. But disregard them. Remember, the harpsichord was no more exotic in its day than the piano or the Hammond organ is today, and it shouldn't sound that way, nor does it. Listen to the harpsichord for what it can give you in *music*, and forget the aesthetes. They're wrong, not you.) In effect, then, the harpsichord cannot be properly heard by most of us in any form but the electronics-treated. It is therefore right in a category with Mr. Globus' P.A.'ed jazz. Very few of us are lucky enough to hear it live, played close-to in a properly chosen acoustic situation.

Band Wagon

But one more quirk of this particular business. Some composers of today, for reasons not entirely artistic, have jumped onto the modest harpsichord bandwagon. Wanda Landowska, the great harpsichord name, has, like most virtuosi, had her large share of works specially dedicated to her for her own performance on the harpsichord. Some are really written for harpsichord. Some, alas, are written for Landowska and more particularly, shall we say, for Landowska's press agents. Period. There are "harpsichord" works that might as well be played on a steam calliope as on a harpsichord! One wonders whether the composer was quite sure which instrument he was writing for.

In contemporary music for the harpsichord, then, some interesting questions arise. Just what effect did the composer have in mind? There are several clear possibilities. 1) The close-to, powerful room-sound of the harpsichord, plus a group of a dozen or so orchestral instruments, perhaps a few more—a very potent sound in the proper balance, as Bach knew well enough. 2) The faint, barely audible tinkle of the harpsichord in a large modern concert hall, especially when "accompanied" by an orchestra of 75 or a hundred pieces. The effect is not to be sneezed at, though it is utterly unlike the above. 3) The opposite effect, where the harpsichord, electronically amplified with its own solo mike, can be made to sound tremendous, *louder than an entire orchestra*—or at least its easy equal, according to taste.

This last effect, (3), has as you probably know, been used quite a bit in popular music. The harpsichord has figured as a solo in more than one name band, and most effectively, too.

But take two interesting examples from the strictly classical field. First, some months back, Landowska played one of her dedicated works, a harpsichord concerto by the French composer Francis Poulenc, in a New York Philharmonic Carnegie Hall concert. The concert was both broadcast and live—and I've had reports from both which are diametrically opposite. Question: just what *did* M. Poulenc intend?

Complaint #1, from Carnegie Hall, where the music, as usual, was entirely unamplified. The piece was nice, but the harpsichord—so went the grouse—was virtually inaudible. Like a good child, Mme. Landowska could be seen but not heard. The orchestra, mind you, was large—no chamber affair. Even that nice, silvery tinkle was lost most of the time. Did Poulenc really mean it that way? If not, then what *did* he mean?

Complaint #2, my own. Friends of mine took down the same music from the wide-range FM broadcast, on hi-fi (15") tape. I've heard it several times. In this version, as broadcast via FM, the trouble is exactly the opposite. The harpsichord is so loud that the large orchestra is more than over-balanced! The mike was so close[1] that the string tone is completely unnatural, and rather ugly. I've heard many a live harpsichord, at proper distance, and I know that a hi-fi mike placed practically inside the machine will give a most unrealistic reproduction of the real harpsichord tone. (Same applies to an oboe or a human voice. My stock term for too-close vocal microphoning is "tonsil-close.")

Now the question is, what did Poulenc intend? Surely he must have counted on the harpsichord being heard! And yet I'm sure he did not intend it to sound as huge and overbearingly metallic as it did in the broadcast. Judging from the texture of the music, I would say that this concerto definitely requires sound reinforcement of the harpsichord to be effective—but not to the degree that CBS thought necessary. Mr. Globus please note.

De Falla

Another example (which *Sat. Review* readers may have seen briefly discussed some months back). This one is quite astonishing. Back in the years between 1923 and 1926 the Spanish composer Manuel De Falla wrote a harpsichord concerto. The date should tip us off that De Falla did *not* contemplate either recording or sound reinforcement! Hardly, in 1925. The orchestra is small, only a few instruments, obviously with the intention of letting the harpsichord get in a word edgewise.

There are two recordings of this work, one with the composer himself, dating from 'way back (though not 1925), the other a wide-range postwar job, with Ralph Kirkpatrick. I knew this music for a good many years solely from its recorded version and it always bothered me. The harpsichord sounded forced, ugly, stentorian in tone, though it was recorded in what seemed a a perfectly proper way—to give the sort of balance that works beautifully with earlier harpsichord pieces of Bach's day. That is, the harpsichord held its own in volume against the combined sound of the small orchestra. But it didn't seem right.

Then came the day, recently, when at last I heard this selfsame work for the first time in a live concert, in New York's Town Hall (seating something like 800 people). *Mirabile dictu,* the music, without any amplification whatsoever, sounded wonderful. The harpsichord took on its modern guise—it came through as that typical faint, etherial tinkle, but this time quite clearly etched against the small orchestra's sound. A lovely, "high fidelity" silvery sheen, with almost no volume at all, yet perfectly clear.

Get it? The light dawned quickly. Manuel De Falla, writing in the 1920's was scoring for the harpsichord *as heard in a large hall minus amplification,* and being a fine musician, he knew how to use that sound to perfection, tiny as it was. Along come the recording engineers and give the music the Bach-Handel treatment, "restoring" it to something it wasn't supposed to be restored to!

I'll have to admit that it will be a fine headache to record that concerto in the style I suggest, as De Falla, I'm quite sure, intended it. Even the harpsichordists themselves are apt to be strangely obtuse, like all soloists, when it comes to balancing

[1] There is one necessary qualification here: this broadcast was miked for AM, not FM. Given the usual restricted AM tonal range, the harpsichord would not have sounded so strangely tinny. Just one more example of the utter unsuitability of the present practice of duplicate AM-FM mike pickups. When will we recognize that FM, like high-fidelity recording, needs very different microphoning from that used in AM? From the standpoint of optimum mike pickup alone, AM-FM duplication is quite indefensible.

their part against other elements. (After all, *they* never hear that faint tinkle—from the keyboard, the harpsichord sounds lovely and loud enough to satisfy any performer's ego!) But perhaps this is academic. I think with this illustration it must be clear that we are just beginning to understand the problems in classical music involved when electronics steps in to alter nature's own balance of sound. And we would all do well, we in the classical field, to study jazz—popular music—and admire the sureness of technique in that realm. No misunderstandings there.

The two recordings of the De Falla Harpsichord Concerto: Columbia MX 9 (2) and Mercury DM 5 (2), the latter an excellent wide-range job. Both on 78.

Offenbach: Tales of Hoffman.
Theatre Nationale de l'Opéra-Comique (chorus, soloists, orch.), Cluytens.
Columbia LP: SL-106 (3)

Here's one of the best LP's to date and it comes from France. It's not one of those hi-fi demonstration recordings, since this involves singing; but even so, you'll find it hard to beat both in clean, accurate higher tones (perhaps not the super-super high ones) and in superb acoustical conditions, sense of "presence," and realism.

But what's really best about this recording is the opera itself and the performance. This one is grand opera Gilbert-and-Sullivan and "Gaité Parisienne" all mixed together—it has all the airs and graces of a fulsome grand op'ry, many serious and quite beautiful or dramatic arias and the like, but also some hilariously funny sections. You don't even need to know French to enjoy these, and the extensive notes on the back of the record cases help immensely. The singing is superb and the acting as good. This is a live, lively, spirited and infectious performance, and you couldn't find a better way to introduce yourself to opera on the grand scale. Incidentally—if you have a yen for French, the diction and the recording here are both so ultra clear that you'll catch most of the French if you have even half an ear for it. Try side 5 for an excellent taste of the work.

Massenet: Scenes Alsaciennes.
Minneapolis Symphony, Mitropoulos.
Columbia LP: ML 2074 (10")

Francaix: Concertino for piano and orchestra.
Berlin Philharmonic, Borchard.

Francaix: Serenade for 12 Instruments.
Hamburg Chamber Orch. Jochum.
Capitol LP: L 8051 (10") (both)

Here are two other French items, while we're on that country. The Massenet is a pleasant suite of incidental numbers, not unlike the Delibes ballet music, with nice tunes, quite a bit of real substance as well. A good demonstration record for quieter moments—when your ears can't take any more Gayne Suite and Scheherezade and Bolero! Recording here is pleasant-sounding, too; none of the too-cold, hard sound of some earlier Minneapolis recordings for Columbia.

Françaix (his name seems to be in the same category as Benjamin Britten's, of Britain) was one of the bumptious upstarts of the pre-World War II France; he is most like the better known Poulenc—both write sassy, witty, humorous music, sometimes dissonant, mostly very straight-forward and consonant. Sometimes you're apt to wonder whether these gents really have anything worth saying at all. Sometimes you can forget the emptiness of their music thanks to its wit and polish, and that applies to these two recordings, very similar, taken from what is probably prewar Telefunken 78 recording.

R. Strauss: Rosenkavalier Waltzes.
J. Strauss: "Gypsy Baron" Overture.
London Philharmonic, Rankl; Kleiber.
London 78:
LA 118 (2)
T. 5362 (1)

Here are two excellent waltz items, to balance off last month's mention of the top-notch LP waltz disc, "Waldteufel Memories," from London. If some readers of this department are waxing wistful over the lack of 78-rpm records here listed—try these and the following, and you'll feel better. I still am at a loss to explain the peculiar "ffrr" quality that attaches to these 78-rpm Londons—and is not duplicated in most of the LP's of the same company—nor do I mean anything derogatory here, for the LP's are to my mind on the whole better than the 78's. It's just that the London LP recordings seem to have different acoustics altogether; listening to them blind, the chances are that you would not recognize them as "ffrr". (I haven't heard yet, or heard of, any duplication in the London catalogue on both 78 and LP—but then London doesn't believe in publicity and I never hear from them one way or the other. For all I know there may be London 45 albums of all the LP's and 78's, though we reviewers haven't officially been notified of the London 45's existence. It's on display in the shops.) . . . In any case, to return to my starting point, the above waltz recordings are the real ffrr, just as we've known it for the last few years, and if you like that big, resonant sound, these discs will more than please you. A comparison with the Waldteufel LP disc will be interesting, if you can make it for yourself.

Stravinsky: Petrouchka.
Orchestre de la Suisse Romande, Ansermet.
London LP:
LLP 130

What? Did I somehow manage to overlook this last month? Quite unintentional, for this is the top LP-of-the-season, without doubt. All the sound effects you could want, terrific recording, a demonstration record *par excellence* for your LP equipment. I make only a mild reservation; I don't find myself too het up over the Ansermet performance. It seems slow, logy, heavy, throughout—it doesn't dance, and after all, this is dance music. I'll take the very old Stokowsky version any day, musically speaking. This LP, incidentally, replaces the older ffrr Ansermet version which was made with a different orchestra by Ansermet. It's a definite improvement, even a big improvement, believe it or not. (The old one was not one of the best ffrrs, even at the time.) And so much for London, which has taken away quite a bit of our space. Deservedly.

Bach: Jesus, Dearest Master (Jesu meine Freude).
RCA Victor Chorale, Robert Shaw.
RCA Victor 45:
WDM 1339 (4)

Bach: The Well Tempered Clavier, Book I:
RCA Victor 45:
WDM 1338 (6)

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AUDIO ENGINEERING

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Preludes and Fugues #1 through #8.
Wanda Landowska, harpsichord.

RCA Victor LP: LM 1017

Here is the RCA contribution to the Bach Bicentennial (1750 was the year he died) and, incidentally, the first of the RCA LP ("long play") recordings sent out to reviewers. The Landowska thus is the first release from this company to appear almost simultaneously on all three speeds. I have the 45 and the LP and frankly, I don't see any vital difference in quality, unless it is ever so slightly in favor of the LP. Both are from tape (as almost all the first RCA LPs will be) and both are, as we might expect, excellent. The LP record has a gratifyingly smooth almost waxy surface, silent, with neatly bevelled edges. The patching is, of course, perfect and as usual, the greatest contrast between the two versions is the inestimable advantage of unbroken performance. That advantage is only to be judged on a personal basis; for some of us it is of very little importance, for others (and this includes me) it is hardly less than priceless. Judge for yourself! The harpsichord recording (as distinct from the processing) is not ideal here, nor was it in the earlier Landowska Bach Goldberg Variations. There is too much of a wiry, twanging sound, and I cannot believe it is inherent in the Landowska harpsichord itself. Not bad enough, however, to interfere with the enjoyment of this first in a series that will take in all 48 preludes and fugues—96 separate numbers! A tremendous undertaking, and any person who has studied any of these keyboard works for as much as ten minutes will find here a source of inspiration, and more important, information on the actual performance of the works, which is unparalleled. Landowska is a great interpreter.

The motet for unaccompanied chorus, "Jesu Meine Freude," is impeccably sung by the Shaw group, with considerably more subtlety of expression, I'd say, than in earlier Shaw Bach recordings, which tended to be just a bit jejune, brash, in spite of the outward finish and accuracy. Recording is beautifully done, acoustically speaking.

Schumann: Manfred Overture; Weber, Abu Hassan Overture.
London Philharmonic, Schuricht.

London 78: LA 115 (2)

Brahms: Variations on a Theme of Haydn, Opus 56a.
London Philharmonic, van Beinum.

London 78: LA 116 (2)

More for the 78 users—to add to the above waltzes. Same orchestra, same fine recording. The London Philharmonic at this point is a good orchestra, but not quite as accurate in its playing as some of the other top-flight groups, or so its recent records would indicate. (Might be plain lack of rehearsal.) It seems to be recording with dozens of guest conductors these days. These two albums are representative of solid, middle-to-heavyweight Romantic music, impressive stuff for big speakers in bigger enclosures. The Brahms and the Schumann are familiar items, the "Abu Hassan" of Weber, one side, a rarity. It has a luffly triangle, that practically drowns out the rest of the orchestra. Must have had its own private mike. Peppy music, not as flowery (nor as important) as the other items. These are good to excellent performances by top notch continental conductors; a few bloops and plops from the orchestra mar their musical effectiveness but you won't be bothered too much by these.

Employment Register

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

• **Electrical Design Engineer Wanted:** By large, modern, Eastern manufacturing firm for experimental development work in industrial electronics. Applicant must have degree in electrical engineering with communications or electronic option or equivalent in 10–15 years practical experience. Give details, including age, education, experience, references, availability, and salary expected. Box 401.

• **Wanted:** E. E., electronics major, with extensive bkgnd in magnetic and audio cct design and acoustical theory and practice. Must have at least 5 yrs exp. in product design on products now being sold nationally. Must be capable of following product from experimental through production, and be responsible for specifications, quality control, field tests, operation and service manuals on product developed. Must be creative and have an exceptionally high degree of mechanical aptitude. State age, education, and qualifications when answering. Location: Minnesota. Box 102.

• **Audio and Electrical Engineer:** MS in physics; MS in EE. 10 yrs research, development, and design experience with magnetic and disc sound recording, acoustic measurements, and transducers. Also experienced in magnetic recording systems for computer applications. In present position for 10 years, but desire change to smaller company or consulting firm. Box 402.

• **Audio Engineer.** BEE from CCNY, 25, married. Superior knowledge of music: some informal experience with magnetic recording. Desire position in audio. Salary and location secondary. Box 301.

• **Graduate:** Advanced Technology course at RCA Institutes, 26, married, with knowledge of music, desires position in audio field; salary secondary. Box 101.

• **Audio Engineer:** M.S. Physics, Electrical Engr; ten years research, development, design experience with sound recording, acoustic measurements, and transducers. Thorough bkgnd in magnetic and mechanical recording including magnetic recording systems for computer applications. Presently employed, prefer firm in which could invest capital, small city or suburban location. Box 201.

• **Graduate VTI:** employed at present. Desires position in audio field. Some experience. Age 20, single, and in good health. Willing to learn, and will go anywhere. Box 202.

• **Audio Engineer:** experienced man with family desires position in recording, broadcasting, film, or TV sound. Excellent operator, troubleshooter, and maintenance man. Superior knowledge of classical music. Studio and equipment design and construction experience. Fluent English, French, and German. Willing to relocate. Box 203.

ADVERTISING INDEX

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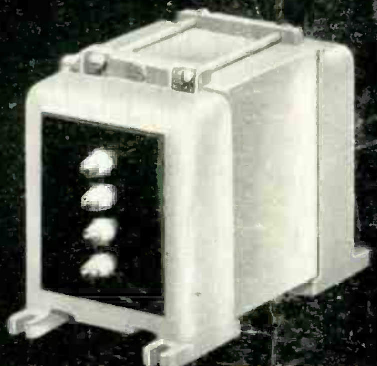

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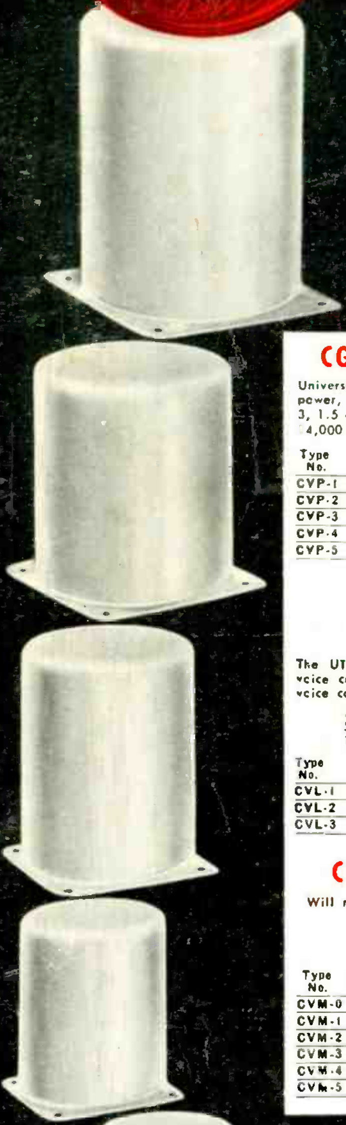

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Universal units designed to match any tubes within the rated output power, to line or voice coil. Output impedance 500, 200, 50, 16, 8, 5, 3, 1.5 ohms. Primary impedance 3000, 5000, 6000, 7000, 8000, 10,000, 14,000 ohms.

Type No.	Audio Watts	Typical Tubes	List Price
CVP-1	12	42, 43, 45, 47, 2A3, 6A6, 6F6, 25L6	$ 9.00
CVP-2	30	42, 45, 2A3, 6L6, 6V6, 6B5	14.00
CVP-3	60	46's, 50's, 300A's, 6L6's, 801, 807	20.00
CVP-4	125	800's, 50's, 807's, 4-6L6's, 845's	29.00
CVP-5	300	211, 242A's, 203A's, 833's, 1-845's, ZB-120's	50.00

CG VARIMATCH LINE TO VOICE COIL TRANSFORMERS

The UTC VARIMATCH line to voice coil transformers will match any voice coil or group of voice coils to a 500 ohm line. More than 50 voice coil combinations can be obtained, as follows:

.2, .4, .5, .62, 1, 1.25, 1.5, 2, 2.5, 3, 3.3, 3.8, 4, 4.5, 5, 5.5, 6, 6.25, 6.6, 7, 7.5, 8, 9, 10, 11, 12, 14, 15, 16, 18, 20, 25, 23, 30, 31, 40, 47, 50, 63, 69, 75.

Type No.	Audio Watts	Primary Impedance	Secondary Impedance	List Price
CVL-1	15	500 ohms	.2 to 75 ohms	$ 8.00
CVL-2	40	500 ohms	.2 to 75 ohms	11.50
CVL-3	75	500 ohms	.2 to 75 ohms	17.50

CG VARIMATCH MODULATION UNITS

Will match any modulator tubes to any RF load

Primary impedances from 500 to 20,000 ohms
Secondary impedances from 30,000 to 300 ohms

Type No.	Max. Audio Watts	Max. Class C Input	Typical Modulator Tubes	List Price
CVM-0	12	25	30, 49, 79, 6A6, 53, 2A3, 6B5	$ 8.50
CVM-1	30	60	6V6, 6B5, 2A3, 42, 46, 6L6, 210	14.00
CVM-2	60	125	203, 6L6, 800, 4-46, T-20, 1608	20.50
CVM-3	125	250	800, 807, 845, TZ-20, HK-30, 35-T	30.00
CVM-4	300	600	50 T, 203A, 805, 838, T-55, ZB-120	50.00
CVM-5	600	1200	100, HF-300, 204A, HK-354, 250TH	115.00

INPUT, INTERSTAGE, MIXING AND LOW LEVEL OUTPUT TRANSFORMERS

(200 ohm windings are balanced and can be used for 250 ohms)

CG Type No.	Application	Primary Impedance Ohms	Secondary Impedance Ohms	List Price
131	1 plate to 1 grid	15,000	135,000 3:1 ratio	$ 9.50
132	1 plate to 2 grids	15,000	135,000 center tapped 3:1 ratio overall	10.00
133	2 plates to 2 grids	30,000 P to P	80,000 overall 1.6:1 ratio overall	12.50
134	Line to 1 grid hum-bucking	50, 200, 500	80,000	12.50
135	Line to 2 grids hum-bucking	50, 200, 500	120,000 overall	13.50
235	Line to 1 or 2 grids, hum-bucking; multiple alloy shielded for low hum pickup	50, 200, 500 ohms	80,000 overall	17.50
136	Single plate and low impedance mike or line to 1 or 2 grids Hum-bucking	15,000, 50, 200	80,000 overall	13.50
233	PP 6C5, 56, similar triodes to AB 45's, 2A3's, 6L3's, etc.	30,000 P to P	25,000 overall .9:1 ratio overall	11.00
333	PP 6C5, 56, similar triodes to fixed bias 6L6's	30,000 P to P	7,500 overall .5:1 ratio overall	11.00
433	PP 45, 2A3, similar tubes to fixed bias 2 or 4 6L6's	5,000 P to P	1,500 overall .5:1 ratio overall	12.00
137	Mixing	50, 200, 500	50, 200, 500	10.00
140	Triode plate to line	15,000	50, 200, 500	12.00
141	PP triode plates to line	15,000	50, 200, 500	13.50

United Transformer Co.

150 VARICK STREET • NEW YORK 13, N. Y.

EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y., CABLES: "ARLAB"

For full details on this line, write for Catalog