AUDIO ENGINEERING

FEBRUARY 1951
35c

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Wherever Magnetic Recordings Are Made
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THE EVER GROWING PREFERENCE for Audiotape is largely a matter of *experience.*
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The superior magnetic and mechanical properties of Audiotape are the *result* of experience, too — more than a decade of engineering and production know-how by the *only* company in America devoted solely to the manufacture of fine sound recording materials — discs, tape and film.
That's why the Audiotape line has grown so large and so fast. In addition to the standard ¼" tapes, Audio is now supplying a wide variety of special sizes — up to 8" in width — for specialized applications of sound reproduction. The new Audiofilm*, developed for the motion picture and TV industries, is a typical example.
Whatever your magnetic recording requirements — for standard or special tapes — remember that you can always depend on Audiotape. Get in touch with your nearest Audiotape distributor, or write to our New York office.
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AUDIO ENGINEERING

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FEBRUARY, 1951 Vol. 35, No. 2

COVER

Progress in phonograph styling is shown by the montage of models from 1878 to 1951. The instrument at the upper right is one of the first models built by Edison, and used tinfoil sheets for the recording medium. Other Edison machines are: the Gem, circa 1900, with the morning glory horn; the compact 1910 table model at the bottom; and the console from the twenties. The familiar dog—Nipper—listens to an early Victor model, and the modern is represented by the wholly new 45-r.p.m. phonograph with its rapid changing mechanism, introduced about a year ago. Photos courtesy of Thomas Alva Edison Foundation and RCA Victor Division, Radio Corporation of America.

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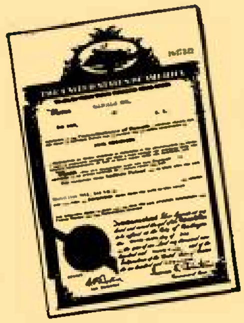


AUDIO PATENTS

RICHARD H. DORF*

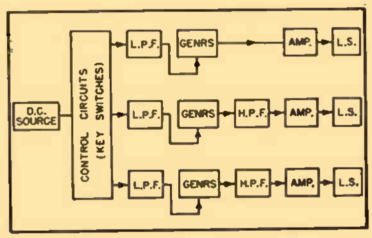


Figure 1

One of the worst problems in the design of an electronic musical instrument is keying. The playing keys cannot operate simple switches which activate an oscillator or complete an audio circuit to send tone to the amplifying system, for this would bring the kind of attack and decay characteristic of a code-practice oscillator; the effect is totally unmusical, no matter how true the pitch or how interesting the tone quality once it has been keyed. The Baldwin electronic organ gets around this problem by having each key operate variable resistors in series with the audio lines, so that as each key is pressed contact is made gradually and the tones build up slowly. That kind of arrangement is difficult to construct, however, without factory facilities.

A more practical solution is the use of a control tube normally biased to cutoff. When the key is pressed, a switch closes, sending positive voltage to the grid and unblocking the tube so that the tone goes to the amplifier section of the instrument. To provide gradual buildup of tone, the d.c. passes through an R-C time-constant network.

Here again, however, the designer is between the devil and the deep blue sea. If the R-C network has the right time constant to provide a perfectly musical buildup delay, the surge of d.c. is fast enough to be the equivalent of a portion of a low-frequency audio cycle; the resulting rush of electrons from cathode to plate results in a thump in the speaker. If the time constant is made long enough to avoid this, the attack is far too slow (at least when the higher notes are being played) to allow muscial facility.

L. E. A. Bourn of Ashford, England, has a helpful idea for designers of instruments in which d.c. is used to control tone generation in this way. His patent is No. 2,507,884 and its workings are very simply illustrated by the block diagram in *Fig. 1.*

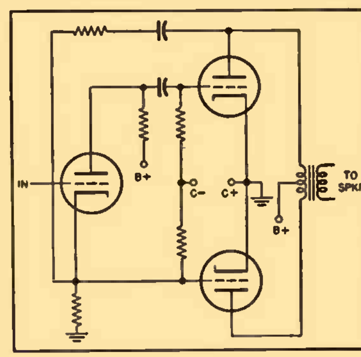


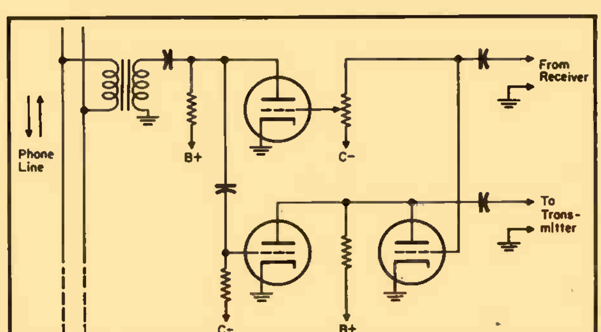
Figure 2

The primary idea is to divide the musical range into two or three sections. With the lower notes, a rather long attack time can be tolerated; in the middle range the attack must be somewhat more brisk; and with high notes the attacks should be very snappy.

The source of d.c., after being keyed by the switches associated with the playing keys, is channeled through a low-pass filter or time-delay network (for practical purposes both are the same) to each of the lower frequency tone generators or control tubes (depending on which one is used in a blocked-grid or similar system). There

* *Audio Consultant, 255 W. 84th St., New York.*

Figure 3



is, of course, a separate network for each note. For the lower notes, each network can have a time constant long enough to eliminate thumps.

The networks for the middle range of notes have a shorter time constant for better musical effect. The thumps which result are removed by a high-pass filter following the combined outputs of all the middle-frequency generators. The cutoff frequency of this filter is just below the fundamental frequency of the lowest note of the middle range, and, when the time constant is well chosen, is *above* the frequency of the thump.

The networks for the high range are of still shorter time constant, giving rise to a thump of higher-frequency (perhaps almost a click). However, a high-pass filter follows the combined high-range generator outputs with its cutoff above the thump frequency and just below the lowest musical frequency of the high range.

This entire arrangement is, in a sense, composed of compromises, but it does allow better musical attacks without keying noises. Actual circuits were not given in the patent, but existing ones can be used with just two important changes—faster time constants for the upper-frequency notes and division of the instrument into two or three ranges, with high-pass filters inserted. Through the inventor's block diagram shows the three channels completely separate as far as the loudspeaker, there seems no reason why they cannot be recombined following the high-pass filters to feed into a common amplifier system.

Phase Inverter Improvement

A common phase inverter is the type in which the output of a single tube is split between equal resistances in the plate and cathode circuits and the grids of the push-pull output tubes fed from the cathode and plate. Though the current feedback in the unbypassed cathode resistor of such an inverter helps its linearity, there is an inherent unbalance between the two outputs at high frequencies. This stems from the fact that the cathode-to-ground impedance of a tube is much lower than the plate impedance, entirely irrespective of the cathode resistor value. Thus stray capacitances, when they enter the picture, make a much bigger impression across the plate output than across the cathode output.

Patent No. 2,510,683 by inventor Edmond E. Carpentier of Eindhoven, Netherlands, shows how an improvement can be made by adding negative feedback from one side of the push-pull stage. The circuit appears in *Fig. 2.*

As the drawing shows, the circuitry appears standard except for the series resistor and capacitor between the plate of the upper output tube and the cathode of the phase-inverter triode. As can be traced, the output of the upper push-pull tube is in phase with the inverter cathode voltage and reinforces it. This makes for more current feedback in the cathode resistor. However, the value of the cathode resistor is reduced so that feedback in the triode remains the same as without feedback of this kind, and voltage output to the lower power tube remains equal to that for the upper tube. Thus at least half of the power stage is included in a new negative feedback loop, with the usual advantages.

In addition to this (though not mentioned in the patent) it appears that balance is aided. Unbalance in this kind of inverter is usually caused by a drop in the inverter

[*Continued on page 40*]

Hollywood Letter

C. A. HISSERICH*

RECENT TECHNICAL DEVELOPMENTS in motion picture sound recording are largely those resulting from the transition from optical to magnetic original sound records.

Most of the equipment utilizes perforated 35-mm stock although some split 35-mm stock is used for portable equipment in the interest of weight saving.

The technical problem of splicing has been solved by several new splicing machines recently introduced and the problem of cutting has been simplified by automatic machines which scribe a visible inked oscillograph-type trace on the magnetic film alongside the modulation.

Work is also underway to develop some chemical method of rendering the magnetic modulation visible. Promising results in this direction have been achieved, but to date it has not been used commercially.

Long-playing recording equipment—utilizing 5000-foot reels—has been in use, largely for music recording. These machines presented formidable technical problems in the starting and stopping of the 60-lb reels, but these problems were solved thru the utilization of magnetic clutches for aided starting.

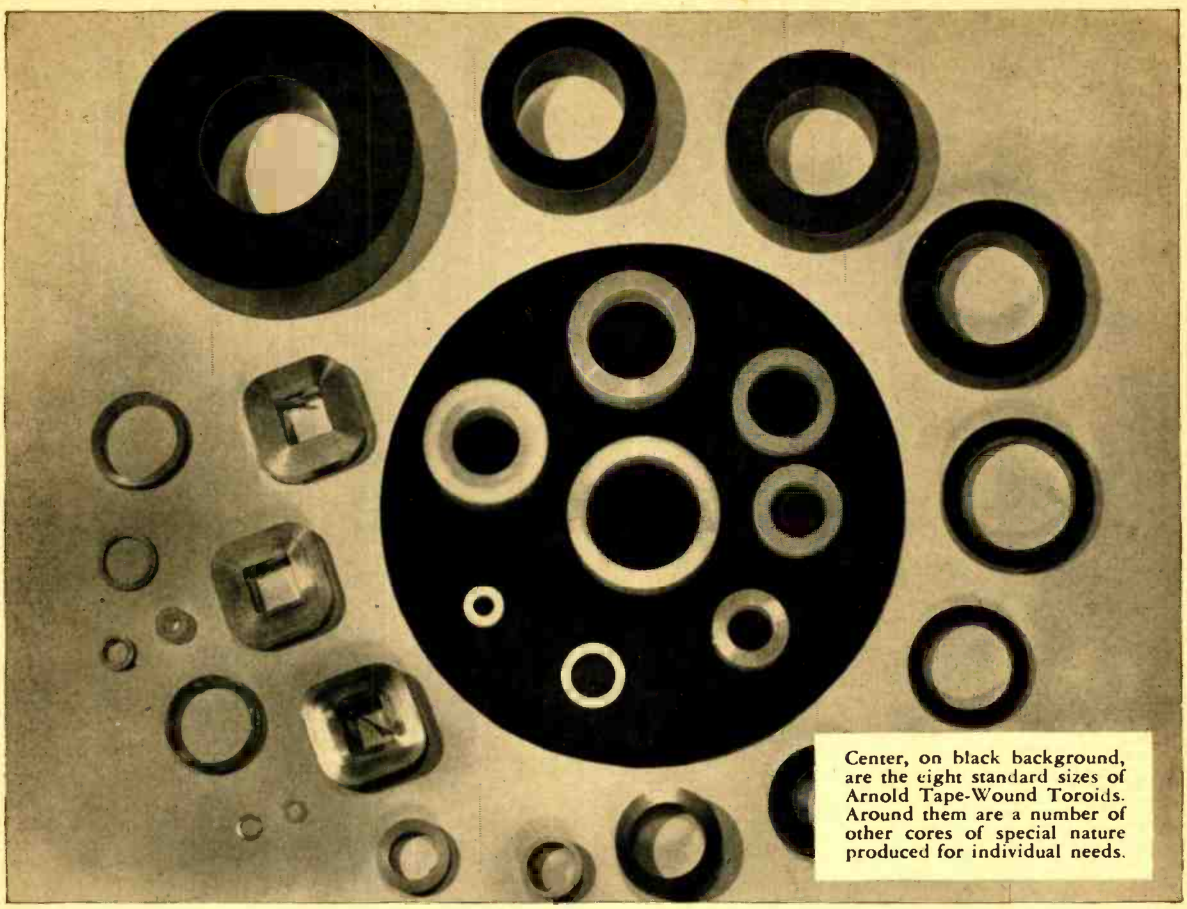
The transition to magnetic recording has generally resulted in simplified operation and improved quality in the original recordings. The equipment does not require the critical field adjustments which were previously required by the optical modulators. However, one preliminary or "shop" adjustment was found to be very critical; this is the adjustment of recording and playback head pressures. Too light a pressure results in excessive high-frequency amplitude modulation and, in extreme cases, complete loss of signal if the pressure is light enough to allow film dirt to pile up under the head. Excessive head pressure results in "bad motion" in the recording equipment as well as excessive head wear and in rare cases a disturbing form of film "chatter" as it passes over the head.

A useful tool for properly adjusting head pressure is an audio sweep generator (similar to the Clarkstan) which permits the audio spectrum to be displayed on an oscilloscope. In the use of this equipment, the head pressure is gradually increased until the high-frequency amplitude modulation is minimized.

Practically none of the motion picture magnetic recording equipment is supplied with erase facilities, largely because of the ever present hazard of ruining several hour's work. It has also been found that while erasing is possible in the machines if sufficient power is available, the film thus erased is not as low in background noise as that which is erased by an over-all a.c. field.

[*Continued on page 39*]

* *954 Hancock Ave., Los Angeles 46, Calif.*



Center, on black background, are the eight standard sizes of Arnold Tape-Wound Toroids. Around them are a number of other cores of special nature produced for individual needs.

ARNOLD TAPE-WOUND TOROIDAL CORES

of DELTAMAX
4-79 MO-PERMALLOY
SUPERMALLOY*

In addition to the standard toroids described at left, Arnold Tape-Wound Cores are available in special sizes manufactured to meet your requirements—toroidal, rectangular or square. Toroidal cores are supplied in protective cases.

Manufactured under licensing arrangements with Western Electric Company.

W&D 3182

APPLICATIONS

- MAGNETIC AMPLIFIERS
- PULSE TRANSFORMERS
- NON-LINEAR RETARD COILS and TRANSFORMERS
- PEAKING STRIPS, and many other specialized applications.

RANGE OF SIZES

Arnold Tape-Wound Toroids are available in eight sizes of standard cores—all furnished encased in molded nylon containers, and ranging in size from ½" to 2½" I.D., ¾" to 3" O.D., and ⅛" to ½" high.

RANGE OF TYPES

These standard core sizes are available in each of the three magnetic materials named, made from either .004", .002" or .001" tape, as required.

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

LETTERS

Output Transformers

Sir:

The output transformer transient which occurs in a class AB or B amplifier when one tube cuts off has been traced to leakage inductance between the sides of the primary winding. Accordingly, a bifilar transformer has been utilized in the McIntosh design to produce an efficient, high-fidelity amplifier. I would like to offer a few thoughts on the solution of this problem without a special output transformer.

Remote cutoff output tubes could approximate class B operation without the necessity for cutoff. Nominally such an amplifier would operate in class A, in fact. Considerable third harmonic distortion would be generated by the more-than-usually curved characteristics of these tubes, but it could be overcome by feedback. Unfortunately there are no remote cutoff tubes available at present with ratings in the 6V6-6L6 range, but for those interested in experimenting with the scheme, the tube handbook indicates that a pair of 6AB7s will deliver about 3 watts in this service under the following conditions:

$E_b = 300$ v; $E_{sg} = 200$ v; $E_c = -5$ v; quiescent $i_p = 5$ ma per tube.

The same result could be achieved with ordinary tubes by compressing the negative driving swings at the grids of the output tubes. A crystal diode circuit might be designed for this purpose.

An amplifier of the sort I suggest would, like all class B amplifiers, be characterized by low quiescent plate current. At full load the plate current would roughly double. But since full output is required only during transient peaks, the additional current could be supplied by the output filter capacitor, so that the power supply need be designed only for quiescent conditions or a little above. A regulated supply would also be of help in this connection, and would offer a number of other advantages, including a reduction in power supply feedback, maintenance of screen voltages, and possible elimination of the filter choke.

Joseph M. Diamond,
Moore School of Research,
University of Pennsylvania,
Philadelphia 4, Penna.

Listener Preference Tests

Sir:

I would like to list a few observations about listeners to and listening tests of wide-band audio systems, hoping that they might be of some interest to audio men.

1) Many listener tests appear to verify the contention of some engineers who have pointed out that conducting a scientifically controlled test does not necessarily guarantee a set of scientific deductions.

2) It has often been said that the "average" listener doesn't "appreciate" wide-band audio. The writer's experience has been that what the average listener fails to appreciate is not so much the wide-band signal but the high price tag. We never heard anybody claim that a $10 speaker was better than a $150 unit.

3) Listener tests keep harping on the "average" listener. Statisticians have pointed out repeatedly that no such individual exists; but if one did, he would be truly a fantastic creature.

[*Continued on page 10*]

NEW CONVERSION KITS

- MI-11882 for fine-groove cutting.
- MI-11860 and MI-11861 for 45 RPM operation.

The standard high-fidelity recorder for TV and Broadcast Stations, Professional Studios, and Advertising Agencies.

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IN PRICE . . . lowest in RCA history* . . . the 73-B compares with any recorder of similar quality!

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Kit MI-11882 makes it easy to convert your 73-B recorder to cut fine-groove recordings—*and reduce your recording costs one half!*

New motor drive pulleys make it practicable to operate your 73-B at 45 RPM—and utilize this speed, plus either 33⅓ or 78 RPM. (MI-11860 for 45 and 33⅓ RPM, and MI-11861 for 45 and 78 RPM.)

Easy to operate, this professional recorder offers technical and economical advantages matched by no other recorder in its class. For details ask your RCA Broadcast Sales Engineer. Or write Dept. N 7 RCA Engineering Products, Camden, N. J.

*Ask your RCA Broadcast Sales Engineer for the special package price!

Look at these low operating costs!

Specifications	Records		
	Normal Groove	Fine-Groove 16"	Fine-Groove 12"
Record Cost per Hour (Records only)	$4.00	$2.00	$2.20
Cu. in. storage space needed per hour of recorded material	36	18	20

AUDIO BROADCAST EQUIPMENT

RADIO CORPORATION of AMERICA

ENGINEERING PRODUCTS DEPARTMENT, CAMDEN, N.J.

In Canada: RCA VICTOR Company Limited, Montreal

EDITOR'S REPORT

FREQUENCY CORRECTION

How does one equalize a sound reproduction system for a person who has a hearing deficiency? This question arises occasionally in discussions of quality music systems, and is usually the result of a constructor desiring to give the user a response which attempts to correct for high-frequency losses accompanying increasing age.

The fundamental philosophy of reproducing systems is generally considered to favor the re-creation of a performance in a manner which is as nearly as possible a facsimile of the original. When a person with any type of hearing deficiency goes to a "live" orchestra concert, he does not hear the entire range of frequencies present in the performance. Instead, he hears only that portion of the audio spectrum which is within his own personal pass-band. In effect, then, there is an equalizer or filter—depending upon the type of deficiency—between the sound source and his ultimate sense of hearing.

When this same person later hears, for example, a tape re-broadcast of the same performance through his music reproducing system, he should normally expect to hear it exactly as he did in the concert hall. If such is to be the case, then, it is fairly obvious that the reproduced music should be as nearly as possible an exact facsimile of the original—just as it should be for a person of normal hearing.

Carrying this hypothetical case further, suppose that our hearing-deficient listener should take his younger, normal-hearing wife to the same concert with him. She can hear the entire frequency range of the orchestra. Of course she doesn't hear the performance just as he does, but each hears a live orchestra. Each knows it is a live orchestra because each can see it. When they listen to the re-broadcast on a facsimile system, each will hear just what he heard in the concert hall—which is as it should be—disregarding the effects of the monaural microphone vs. the binaural direct hearing.

Suppose, on the other hand, that some wise builder has had the customer take an audiogram and has then corrected the frequency response of the installation to compensate for the hearing deficiency. What does the wife hear when she listens to the re-broadcast? That is approximately the $2 question.

Now let us consider a more serious problem, that of the person responsible for the quality of a broadcast or a phonograph record. This person—whom we shall call the producer—is likely to have to judge the performance in an inadequate monitor booth, with a makeshift speaker installation, and under listening conditions that are somewhat less than ideal. It seems desirable that every element of a monitoring system—electrical, acoustical, physiological, and psychological—should be planned so that the producer should be able to devote his entire attention to listening. We submit, therefore, that the ideal monitoring room should be of a size similar to a typical living room, should have similar acoustics, and should contain only the producer and the engineer, with the latter so placed as to be able to view the studio. For others who want to see and hear what is going on, a separate booth should be provided, more like those now in use. At least, let the two most responsible for the final result work under more ideal conditions. It goes without saying that the frequency response of the entire system—from microphone to the acoustic output of the speaker—should be flat, and that once set up for a satisfactory product nothing should be changed, not even the monitor level.

By far the largest percentage of program output is heard, unfortunately, over equipment which would have trouble with the frequency range of an ocarina, but it is still necessary to make that product good enough to sound right on the finest reproducing systems.

CHICAGO AUDIO FAIR

Conditions affecting our industry have changed appreciably within the past month, and it has been decided that there will be no Audio Fair in Chicago, for this year at least. Let us all hope—for many reasons—that THERE WILL BE TWO IN 'FIFTY-TWO.

IRE NATIONAL CONVENTION

The 1951 Convention of the Institute of Radio Engineers opens on Monday, March 19, and continues for four days. Broadcast engineers will be most interested in the symposium to be held Tuesday morning on the subject of Broadcast Transmission Systems. A session of interest to practically anyone involved in audio is to be held on Thursday morning on the general subject of Audio; on Thursday afternoon the symposium on Loudspeakers falls in the same category. TV broadcast engineers will be interested in the symposia on the Empire State TV Antenna System and on Color Television, to be held on Tuesday afternoon and evening respectively.

In all, nearly 200 papers are scheduled to be given during the four days of the convention, with the usual exhibit being held in Grand Central Palace during the entire Convention. If you have never attended this exhibit, you would find it well worth your time, for it is the one big show of the year for those products which are not specifically in the audio field.

We'll be there, in Booth 94A, as usual.

HIGH COST OF LIVING

According to a recent article by David Berlyn in *Broadcasting • Telecasting,* Washington "five percenters" have raised their rates to seven-and-a-half per cent, thus confirming what everyone is rapidly finding out for himself.

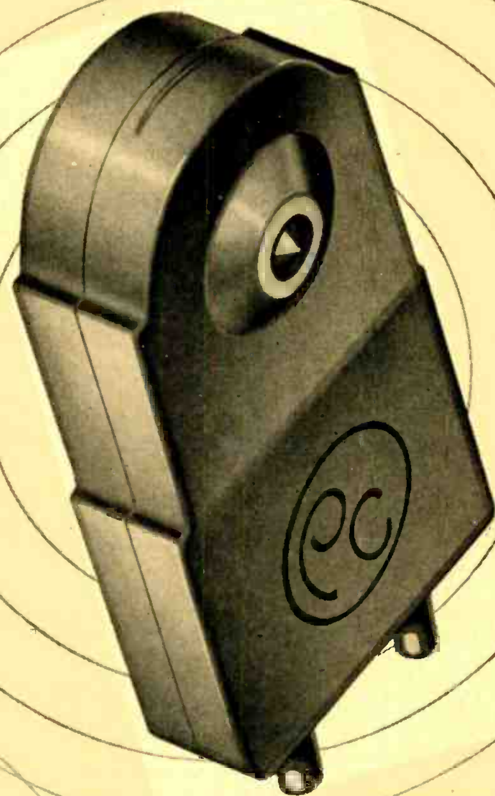
No further comment.

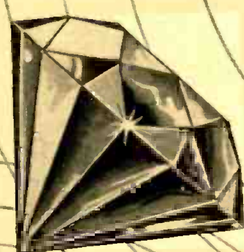
PICKERING

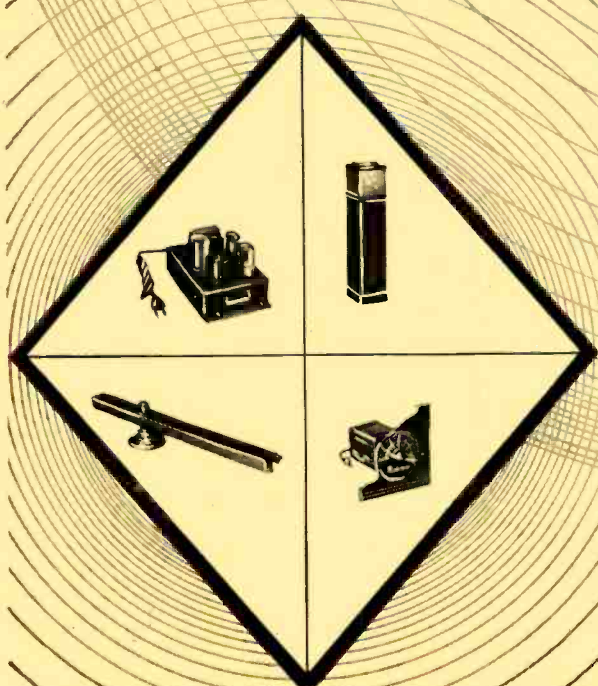
diamond stylus pickups

ACKNOWLEDGED BY ENGINEERS AS THE FINEST AVAILABLE!

- The superiority of diamond styli to styli of other materials has been thoroughly established.
- Exhaustive tests prove resistance to abrasion of diamond styli is many times greater than that of the next hardest material.
- Great resistance to abrasion means a minimum of record wear, longer record life and concert hall quality music all the time.







Pickering pickup cartridges, equipped with diamond styli, may cost more than cartridges with other stylus materials but the useful life of a diamond stylus cartridge is so much greater than is represented in the cost differential that from all practical viewpoints—length of service, listening pleasure, and record life — Pickering diamond stylus cartridges cost less.

The diamonds used in Pickering cartridges are whole diamonds, not splints. They are well cut, gem-polished to high accuracy and precisely mounted to ride free and smooth in the groove walls, recreating all the fine tones and modulations pressed into modern recordings.

The supremacy of Pickering Diamond Cartridges is unchallenged. They meet every exacting requirement of the most critical record playing enthusiast who insists upon the finest musical reproduction; who wants the realism and brilliance of a live performance and who is anxious to maintain the useful life of his record collection.

PICKERING & COMPANY, Inc.
Oceanside, L. I., N. Y.

Address Department A

4) Wide-band enthusiasts are usually assumed to have a common likeness—a liking for maximum bandwidth, period. Audio customers are no different from any other customers and have infinitely varied physiological and mental differences. What is "brilliant" to one set of ears may be "tinny" to another, *ad infinitum*. Distortion is a complex problem and individuals are complex people so it is self delusion to over-simplify wide-band audio by merely talking about "average" listeners and simple sine-wave distortion. Furthermore, human ears develop their own individual distortion effects too.

5) Talk about "pleasing" vs. "realistic" sound reproduction is not very realistic. Distortionless audio does not exist and what is pleasing to a Congo native may not be so to a U. S. school teacher. If an engineer modifies an audio signal in an attempt to make it pleasing to certain "conditioned" ears, he's an artist and not an engineer. His main job is to reduce distortion effects.

6) Why are most listener tests "one-shot" affairs with strange equipment in strange locations? Only repeated listenings with familiar program material on familiar equipment is of any real value.

7) Why pick up John Does off the streets or choose temperamental musicians for "average" listener-test subjects? Does a movie star qualify as an expert movie critic? Do coffee and perfume manufacturers pick up people from the streets to "test" their products? (*According to some display advertising, Yes.* Ed.) The writer's contention is that trained audio engineers should do all the listener testing, with the assistance of capable musicians with technical training.

8) Why are such claims made as "distortionless" reproduction and "the reproduced signal cannot be distinguished from the original?" Anyone who has ever heard the thundering power of a grand organ's bass or the ethereal beauty of its treble knows different, as does anyone who has ever heard the strike tones of reed instruments, cymbals, and drums at close range.

Ted Powell,
42 Nassau Road,
Great Neck, L. I., N. Y.

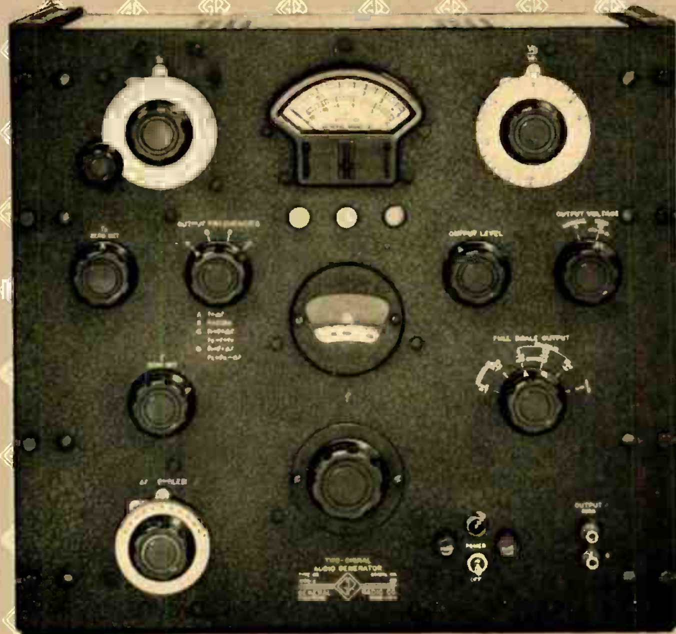
Musician's Amplifier Senior

Sir:

I do not doubt that the "Musician's Amplifier Senior" will have as good a reception as its smaller brother and the designers are to be commended as much for their archeological work in resurrecting the 845 and returning it to its rightful position as for their electronic design.

I would like to point out that in the construction of the power supply it is essential that the filter reactors be connected in the high side and not in the ground leg as shown. If connected in the circuit as originally shown there will be a hum component that is not filterable. This is due to the electrostatic capacitance between the transformer secondary and ground, as shown by Terman and Pickles in "Note on a cause of residual hum, etc.," *Proc. IRE*, Vol. 22, p. 1040, 1934.

C. H. W. Nason,
Robles del Rio,
California



TYPE 1303-A
TWO-SIGNAL GENERATOR
$1050

a *New* Two-Signal Audio Generator

Ideal for Non-Linear Tests On: ☆ *Audio Amplifiers* ☆ *Hearing Aids* ☆ *Filter Networks* ★ *Noise Suppressors* ★ *High-Efficiency Speech Reproducing Systems* ★ *Loudspeakers* ☆ *F-M Systems with Pre-Emphasis* ★ *Recording Systems* ★ *Any System of Restricted Frequency Range*

The new G-R Type 1303-A Two-Signal Audio Generator supplies signals by the beat-frequency method. Three oscillators and three mixers are used to provide a number of output-signal combinations. The output of the mixers are combined in a linear adding network and then amplified through a very low-distortion power amplifier. The output from the amplifier is fed into a 600-ohm attenuator system, with a voltmeter to monitor the level at the input of the attenuator. The harmonic content and inter-modulation products in the final output are at a very low level. High stability of voltage and frequency are provided. The frequency drift from cold start is only a few cycles.

This A-F Signal Generator will supply the following signals:

- A single low-distortion sinusoidal voltage, adjustable in frequency from 20 cycles to 40 kilocycles, in two ranges.
- Two low-distortion sinusoidal voltages, each separately adjustable, one to 20 kc and the other to 10 kc.
- Two low-distortion sinusoidal voltages with fixed difference in frequency maintained between them as the frequency of one is varied. The fixed difference frequency is adjustable up to 10 kc, and the lower of the two frequencies is adjustable up to 20 kc.

The output is continuously adjustable and is calibrated both in volts and in db with respect to 1 mw into 600 ohms. The frequency calibration can be standardized within one cycle at any time. Its accuracy is ± (1% + 0.5 cycle).

This generator is an excellent and versatile signal source for the three standard non-linear distortion tests:

1. The widely used harmonic distortion test.
2. The intermodulation method that evaluates distortion in terms of the resultant modulation of a high-frequency tone by a low-frequency tone.
3. The difference-frequency intermodulation test, which evaluates distortion in terms of the amplitude of the difference-frequency components produced by intermodulation of two sinusoidal test signals of equal amplitude.

Write for Complete Information

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

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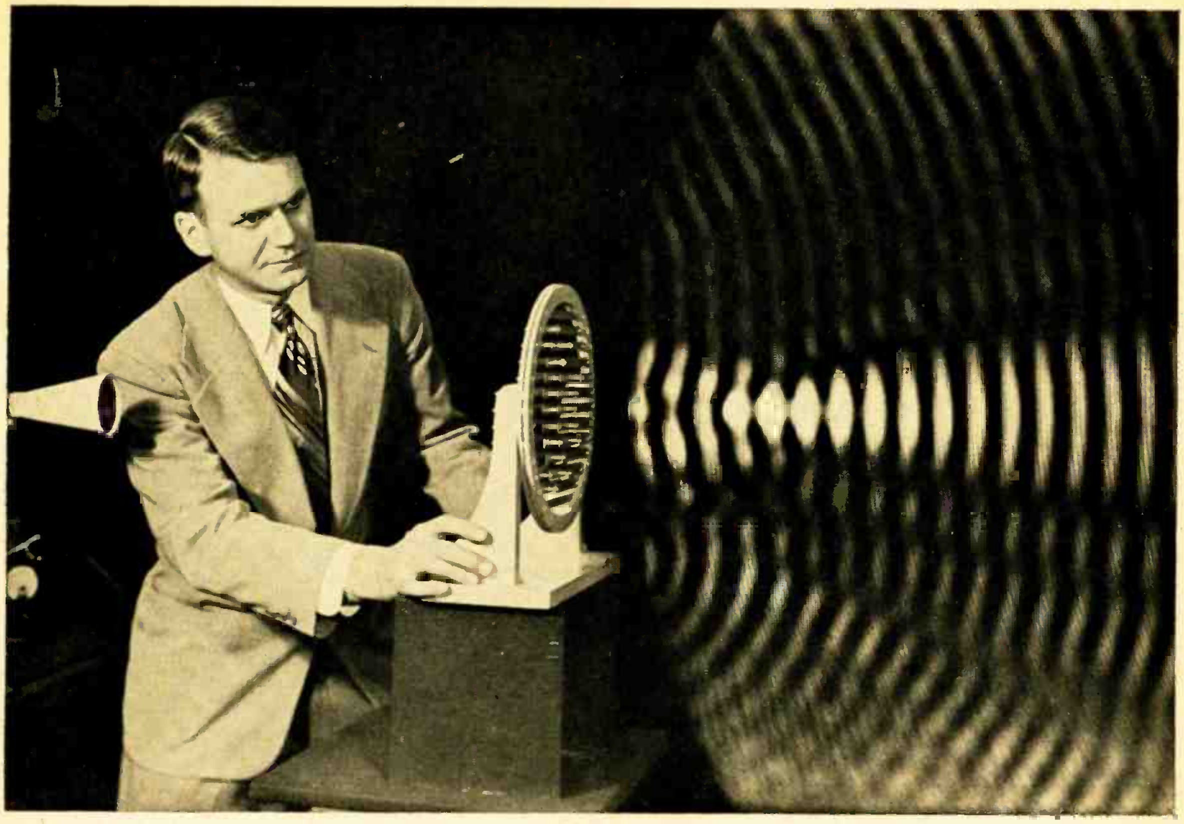

WAVE MAKING

–for better telephone service

Waves from the sound source at left are focused by the lens at center. In front of the lens, a moving arm (not shown) scans the wave field with a tiny microphone and neon lamp. The microphone picks up sound energy and sends it through amplifiers to the lamp. The lamp glows brightly where sound level is high, dims where it is low. This new technique pictures accurately the focusing effect of the lens. Similar lenses efficiently focus microwaves in radio relay transmission.

At Bell Telephone Laboratories, radio scientists devised their latest microwave lens by copying the molecular action of optical lenses in focusing light. The result was a radically new type of lens – the array of metal strips shown in the illustration. Giant metal strip lenses are used in the new microwave link for telephone and television between New York and Chicago.

The scientists went on to discover that the very same type of lens could also focus sound . . . thus help, too, in the study of sound radiation . . . another field of great importance to your telephone system.

The study of the basic laws of waves and vibrations is just another example of research which turns into practical telephone equipment at Bell Telephone Laboratories . . . helping to bring you high value for your telephone dollar.

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Home-Made Parabolic Microphone

GEORGE H. FLOYD*

Constructional details for a device useful in making microphone pickups under difficult conditions.

The increasing popularity of magnetic recording equipment is due in part to the fact that with tape or wire recording apparatus almost anyone can do a creditable recording job with relatively little experience. Add to this the fact that the equipment is low in price, and it is easy to see why thousands of audio enthusiasts have started to do their own recording.

If the recording neophyte confines his activities to recording radio programs, or recording Junior's voice for posterity he will run into very few difficulties. It is only when he attempts recording on a more professional scale that he finds his experience inadequate.

An attempt at recording the work of the church choir, or the high-school orchestra may bring out quite forcibly the fact that microphone technique is an important part of recording. A single microphone, regardless of its quality, can be placed in only one location and the sounds picked up may be entirely different from the overall effect desired. If the acoustics are good it is possible to use a single microphone at a distance and get a somewhat balanced effect, but audience noise becomes an immediate problem. Further, greater gain is required in the preamplifier circuits if the pickup point is some distance from the performers.

A battery of boom-mounted microphones is out of the question for the beginner. In addition to the economic angle, the beginner is faced with a manpower problem. It takes time to install a complex pickup system with its multiple cables, connections and mixing equipment. Further, and perhaps even more to the point, the tyro is interested in doing a good job in as simple a fashion as possible.

Faced with these problems the beginner may well consider the use of a parabolic microphone. It is easy to construct and has many advantages. It may be placed at a relatively great distance from the performers and yet maintain good sensitivity because of its directional qualities and effective gain. Because it is capable of good pickup from a distance one can avoid an unsightly array of microphones close upon the performers.

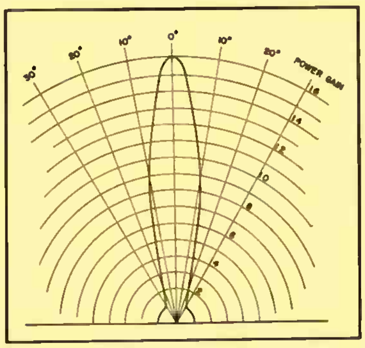

Fig. 1. Polar plot of the power gain characteristic of the author's parabolic microphone. Measurements made out-of-doors to simulate, as close as possible, a free-space pattern. Frequency of measurement: 1000 cps.

Also, because the pickup pattern is relatively sharp the microphone may be placed so that much of the audience noise and room echo is eliminated. *Figure* 1 shows the power gain pattern of the parabolic microphone to be described. Swinging the microphone five degrees each side of the maximum gain position brings about a one db drop in power. In the practical sense this means that the microphone can pick up sound with a plus or minus one-half db variation within a circle having a ten-foot diameter at a distance of approximately seventy feet. From the same distance the variation would be plus or minus three db for a thirty-nine foot diameter circle.

Construction Considerations

A parabolic microphone in its simplest form is comprised of three parts: the parabola, the pickup element, and a means for controlling azimuth and elevation.

Practically any microphone will serve as the pickup element, although velocity microphones are less desirable because they are more sensitive to mechanical shock than other types. Crystal microphones are satisfactory, but it is possible, while recording, to run into conditions of excessive temperature or humidity which might permanently damage a rochelle salt crystal unit.

The best compromise is undoubtedly a high-quality dynamic microphone. The unit employed in the parabolic microphone pictured is an Electro-Voice Model 630. This microphone is rated to have a relatively flat response from 60 to 11,000 cps, which is adequate for most recording work.

The Model 630 is classed as a non-directional microphone, although it is somewhat directional with frequency (above 1000 cps). This characteristic is a function of the diameter of the microphone case. When used with a para-

Fig. 2. The complete parabolic microphone unit mounted on a tripod.

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Fig. 3. Front detail view of the parabolic microphone.

bolic reflector there will be some additional directivity effects at the higher frequencies, but these effects are small compared with the effect of the parabolic reflector itself.

No attempt was made to make a frequency-response measurement of the completed parabolic unit. The on-axis high-frequency response is relatively unaffected, while the low-frequency response is a function of the diameter of the parabolic reflector. With the 27-inch reflector, the response is probably good as low as 150 cps. For applications where full bass fidelity is desirable it will be necessary to reinforce the low frequencies by the use of another microphone, as is explained later.

Other features which caused the 630 to be chosen include its ability to withstand hard usage, both indoors and out; its ability to stand extremes of temperature and humidity; and, of some importance, its shape, which allows it to be clamped easily and located at the focal point of the parabola.

The parabola itself should be purchased. It is possible to make a parabola, but inasmuch as they are currently available on the surplus market at less than $5.00, there is but little incentive to build one. Some of the available parabolas are made of metal mesh which, of course, is not suitable, as a continuous surface parabola is required.

The parabola pictured has a usable diameter of just under 27 inches. Smaller diameter units would give a directional characteristic but the power gain would be decreased.

Attaching the pickup element to the parabola is a simple matter for anyone who is handy with tools. One important point to keep in mind is that the pickup element is somewhat sensitive, acoustically, to mechanical shock, so the mechical construction of the clamp and supporting arms must be such as to minimize the transmission of shock to the pickup element.

Spring suspension is probably not necessary. The author's mount, with reference to *Fig.* 3, is a half-circle removable clamp, felt-lined, which is fastened to a half-circular section, also felt-lined, formed in the horizontal support bar.

The horizontal bar is made of aluminum tubing of ⅝-in. diameter. The middle section is flattened, bent into a half-circle, and drilled to take the mounting screws. A short piece of the same aluminum tubing is flattened and formed into a half-circle and also drilled. Each arc of aluminum is lined with ⅛-in. felt. Wing nuts used on the machine screws for this clamp expedite removal of the dynamic microphone.

The ends of the horizontal aluminum bar are flattened and split to produce a "U" shaped opening which slips over and fastens to the two side supports. These side pieces were made of ¾-in. duralumin. The length depends upon the focal point of the individual parabola. A quick way to check for the focal point is to place the parabola so that you look directly into it. Experimentally place a lighted match near the focal point and move this light source back and forth until the entire face of the parabola is illuminated. This point is the focal point, and you can now decide how long to make the side pieces, although final focusing is accomplished by sliding the microphone back and forth in its clamp. The rear ends of the thick dural pieces are drilled and tapped to permit mounting on the flat front edge of the parabola, while the front end of each side piece is drilled so that the horizontal bar may be attached by machine screws.

Gimbal Construction

The gimbal is made from half-inch thinwall conduit. A standard conduit bender—lent by an electrician friend—made the two necessary bends. This gimbal is brazed (a fifty-cent job at most welding shops) to a piece of ¼-in. brass, 3 inches in diameter. This metal plate acts as a bearing on the top of the tripod, and is drilled and tapped to take the tripod mount screw. A piece of 1/16-in. felt of the same diameter as the metal plate fits between the plate and the top of the tripod to provide a noiseless bearing.

The parabolic mount (without gimbal) is next checked for its center of gravity with the microphone in place. A hole is drilled in each side piece at the center-of-gravity point and the gimbal fastened to the side pieces with machine screws at this point. Use felt washers backed up by steel washers to provide a noiseless friction bearing. Wing nuts used here are useful in obtaining the proper amount of friction.

Damping Requirements

When the parabolic unit is completed and mounted on a tripod, you will notice that the whole unit is relatively "live." This is, of course, undesirable. It was found necessary to deaden the gimbal and the parabola proper.

The gimbal was made sufficiently dead by wrapping with two layers of 1-in. cotton tape and applying a coat of paint over the tape. The parabolic reflector (see *Fig.* 4) was deadened by cementing a layer of ½-in. felt on the rear face.

It is essential that the microphone cable be fastened to the horizontal support bar, the gimbal and one tripod leg so that its motion against any of these elements is eliminated. Friction tape may be used for this job or the cable may be securely tied with cord.

Accessories

Two useful accessories (necessities from the author's point of view) are the sights and the handle.

For accurate alignment of the parabolic microphone a sighting arrangement of some sort is necessary. *Figures* 3 and 4 show clearly the arrangement used. Both the front and rear sight are made of welding rod of a size that can be threaded with a 6-32 die. The front sight is a straight piece six inches long. The rear sight extends out the same distance and is provided with a circular opening made by bending the welding rod around a pipe in a vise. The inside diameter of the circle is approximately one inch.

The handle shown in the photographs is most convenient. It is made quite simply by flattening a piece of 7/8 or 1 inch diameter tubing at one end, drilling two holes, and mounting it on the dural side pieces with machine screws. The bicycle handle-bar rubber grip is not a frill. Any abrupt motion of the hand while it is in contact with the parabolic microphone unit is quite easily heard by the microphone. The rubber hand grip makes it possible to move the unit noiselessly.

When the unit is completed connect the microphone to an amplifier and arrange for a source of constant-level sound to be set up at least twenty feet from the parabola. To avoid unwanted reflections, make this test out-of-doors if possible. Aim the microphone at the sound source and then, watching an output meter on the audio amplifier, adjust the pickup element so that it is at the exact focal point of the parabola. Once this has been done to your satisfaction mark the microphone position so that you will be able to remove and replace the microphone at will.

Another interesting test at this point can be made while using high quality earphones on the output of the amplifier. Move the parabola mount in azimuth and elevation and listen to what the microphone picks up. Check the various parts for liveness by touching with your hand, and listen carefully to be certain that none of the pivot points squeak or make any audible noise.

Performance

Until you become familiar with the capabilities of this unit you may be in for some surprises. The author first tested his unit on the front porch of his home. The slightest chirping of birds, if in line with the microphone, gives the effect of using the microphone in an aviary.

Fig. 4. Rear detail view of the parabolic microphone.

Later the author was puzzled by the sound of children's voices, with no children in sight. Taking a bearing in the direction the microphone was pointed, the author walked the equivalent of a city block before coming across four children playing in the rear of a neighbor's home. Four solid hedges were interposed between the children and the parabolic microphone. This event, perhaps even more than the directional pattern taken later on, was convincing proof that the parabolic microphone really worked.

For recording any sort of stage presentation the author recommends that the parabolic microphone be installed in the front row of the balcony, preferably at the extreme right or left. In this connection it might be well to point out that the parabolic unit may be used in either a right-handed or left-handed manner. Merely move the parabola 180 degrees in elevation to change the handle from the left to the right side or vice versa.

The advantage of balcony placement is that audience noise pickup ahead of the microphone is relatively low due to the directional characteristic of the parabola, and audience noise in the balcony is attenuated by virtue of the front-to-back ratio of the power gain pattern.

With the parabolic microphone alone it is possible to do a good recording job, although it is probable that a better job can be done with two microphones, one a parabolic unit and the other a general coverage microphone.

Most of the author's recording experience has been gained by recording the work of the Schenectady Light Opera Company. In all cases two microphones were used, the parabolic unit balcony-mounted and a velocity microphone placed in the center of the theatre suspended below the balcony. This arrangement requires the services of two men, one to handle the parabola and the other to ride gain and mix the two microphone outputs.

The velocity microphone was used for general coverage pickup in order to get the full effect of the orchestra or chorus. The parabolic microphone was used to pinpoint vocal soloists in the midst of a large chorus. The latter microphone is also invaluable because of its ability to effect "presence" in the pickup of spoken continuity.

Acknowledgment

The author is indebted to D. E. Norgaard, Scotia, New York, for his many excellent suggestions on the design of the parabolic microphone, and his help in testing and using it.

Positive Feedback for A-F Curve Shaping

L. P. HANER*

Part 1. Describing a 15-watt power amplifier with unique high-fidelity characteristics for use in a home entertainment center.

PERHAPS the most pertinent stimulus behind this study has been the realization that a serious paradox exists in our understanding of the requirements of an audio reproducing system. The classical school of thought would have us acquire 10-watt amplifiers with flat response from 20 to 20,000 cps and low harmonic distortion. Several years ago Fletcher and Munson published data on human hearing characteristics which have been given lip service but limited real concern. More recently, we have become concerned with transient response and intermodulation distortion. We are all aware of the shortcomings of our sources of electronically reproduced sound. Highly damped speakers with wide-range response and a smooth characteristic are becoming more and more desired. Microphones, records, transmitters, pickups, amplifiers, transmission lines, and practically all the multitude of steps, thru which the signal must pass, exact their toll—on both ends of the audio spectrum. Obviously, something should be done about it. Herewith, I present my solution—partial though it may be.

First, look for a moment at todays audio amplifiers. They must have a *flat* characteristic thru the audio spectrum. In order to produce maximum speaker damping, low-mu triode output tubes are often used. Occasionally the cathode follower is utilized, or, in its stead, negative feedback from the voice coil of the speaker. Admittedly, these solutions attain a high degree of smooth, clean, accurate reproduction. Now, look at that which is missing. There has been very little consideration for ear characteristics. We've sacrificed valuable gain and power to obtain speaker damping. We ignore the speaker cabinet unless we make highly specialized acoustically perfected units which do not fit the home. It should be self-evident that the only time a really *flat* response is desired is where the sound is reproduced at the same acoustic level it was originally played. Furthermore, if you listen to sound at even moderate volume levels, the response curve should *not* be flat. Note the Fletcher-Munson curves in *Fig.* 1. Just where we want higher level reproduction everything has a failing characteristic.

A few ways are open to us for compensating some of the shortcomings of sound reproducing systems. Good components in a well designed amplifier are essential. Good wide-range speakers in a proper baffle are also essential. The amplifier design itself probably allows the greatest latitude for compensation. Most tone controls or compensators of the dual type are developed to operate from a central frequency, providing adjustable boost or attenuation above and below a central point in frequency. Invariably, this type of compensation rolls off at the extreme ends and therefore only partially fulfills the hearing requirement. It then becomes necessary to employ additional means of compensation—fixed and basic to the main amplifier section. Beyond this it is desirable to make the overall system as positive and stiff as possible. The sound emanating from the speaker should, except for purposeful compensation, be an exact replica, at different volume, of the amplifier input voltage. No embellishments should be added unintentionally and without control by the speaker or amplifier. Unless particular care is exercised, amplifiers and speakers have a strong tendency *not* to reproduce the signal exactly. Pentode and beam power amplifiers are noted for it. Even the best speakers have a multitude of major and

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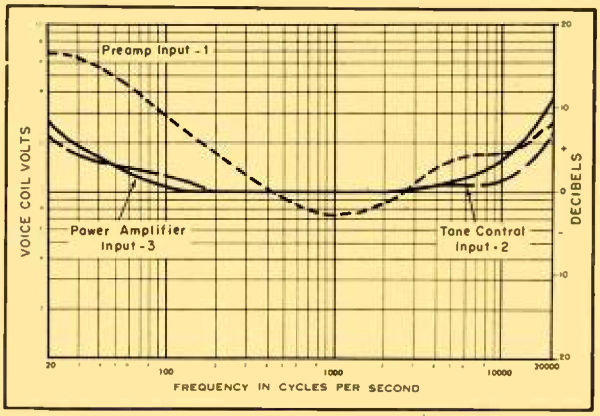


Fig. 3. Response curves of complete installation with tone controls in "flat" position.

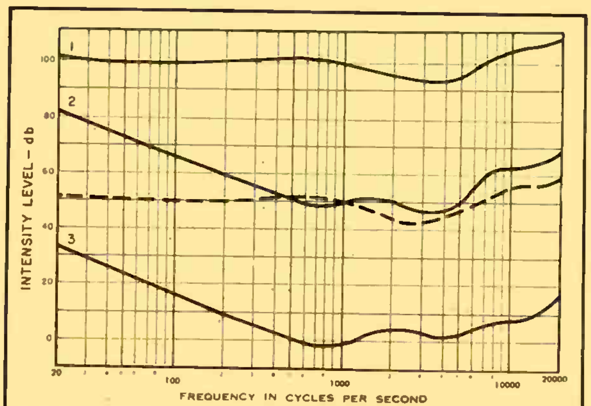


Fig. 1. Simplified Fletcher-Munson curves, to show effect of deficiencies in response curves.

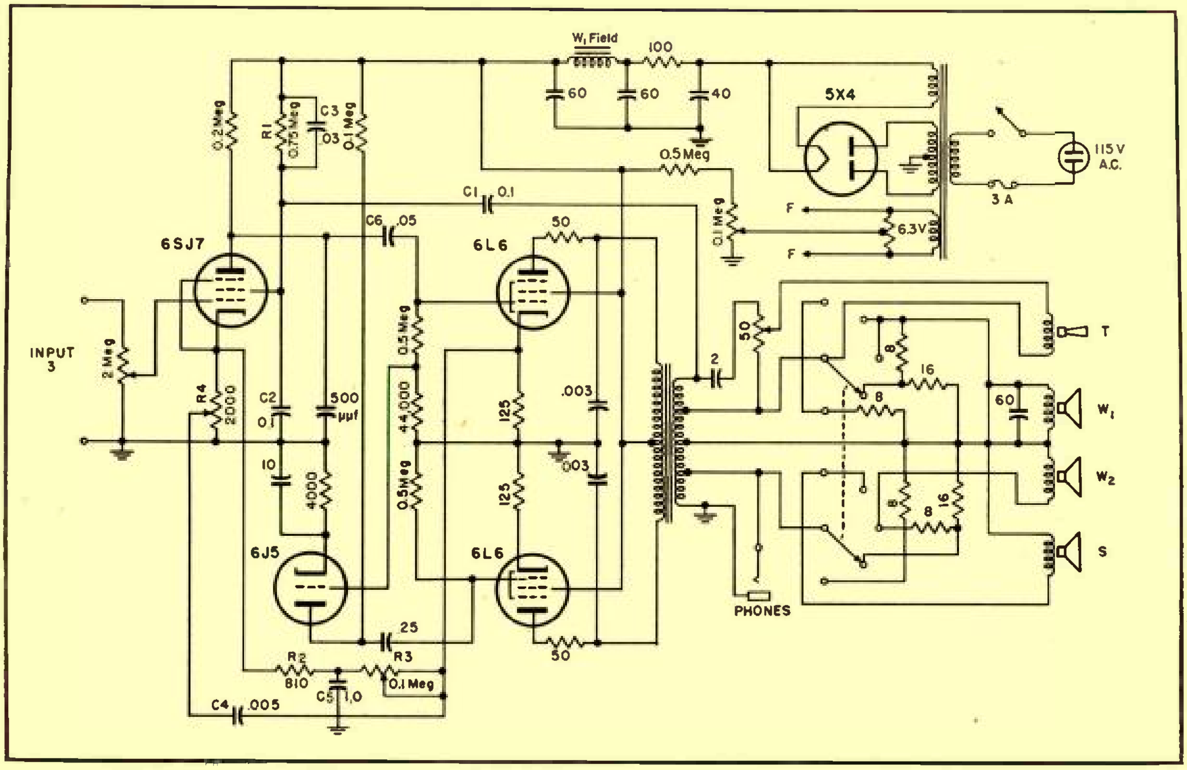


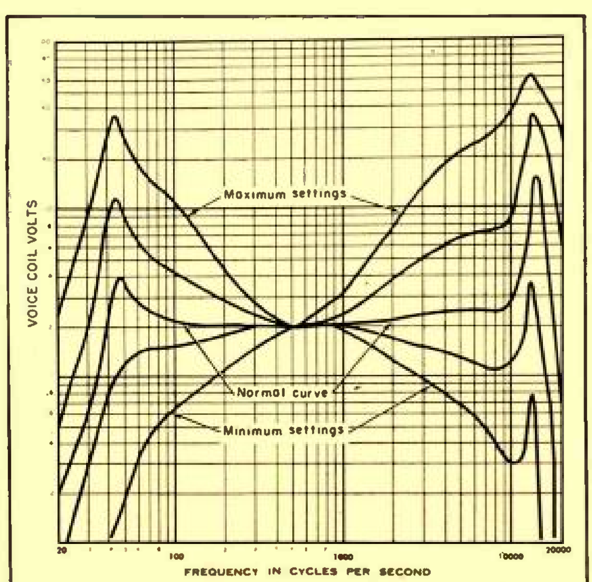
Fig. 2. Output amplifier, power supply, and speaker connection used in the author's installation.

minor resonances which are further complicated by the baffle and its enclosure. There are ways for overcoming these deficiencies to a large degree. Negative feedback from the voice coil reduces the generator impedance of the amplifier and damps the resonances in the speaker. In addition, the voltages set up in the voice coil by its own microphone characteristics provide a compensation source for cabinet resonances and bad room acoustics. The speaker then becomes more integral with the amplifier and reproduces only what is fed to it. Sufficient negative feedback to do this effectively reduces the pentode amplifier gain to such a value that some think a low-mu triode without feedback suffices because of its inherent low plate resistance and, hence, low generator impedance.

The use of positive feedback along with negative feedback goes a long way towards correcting the deficiencies in the pentode amplifier. Further reduction of generator impedance and increased damping becomes possible. In other words, the higher gain allows more negative feedback to be utilized for a given reduction in overall gain. The non-linear characteristics of the output stage, the output transformer, the speaker, and the cabinet become less and less a factor in the acoustic output. They become compensated and respond more positively and absolutely in accordance with the input signal to the amplifier. Poor component quality in the output transformer, speaker, and cabinet, while more easily tolerated, is not advisable, but conditions are much less critical.

Such an amplifier has been developed and is described in this article. This amplifier is part of a home entertainment center—including AM, FM, TV, a 3-speed record changer, a wire recorder, and a separate 45-r.p.m. record changer. It drives three speakers ordinarily—two 12-inch woofers and a tweeter. Switching of another 12-inch speaker in the recreation room is possible; played along with or without the speakers in the entertainment-center cabinet. The TV set may be used in the living room at the same time one of the music sources is being heard in the recreation room. The

Fig. 4. Curves possible with tone-control arrangement provided, and by adjustment of positive-feedback.



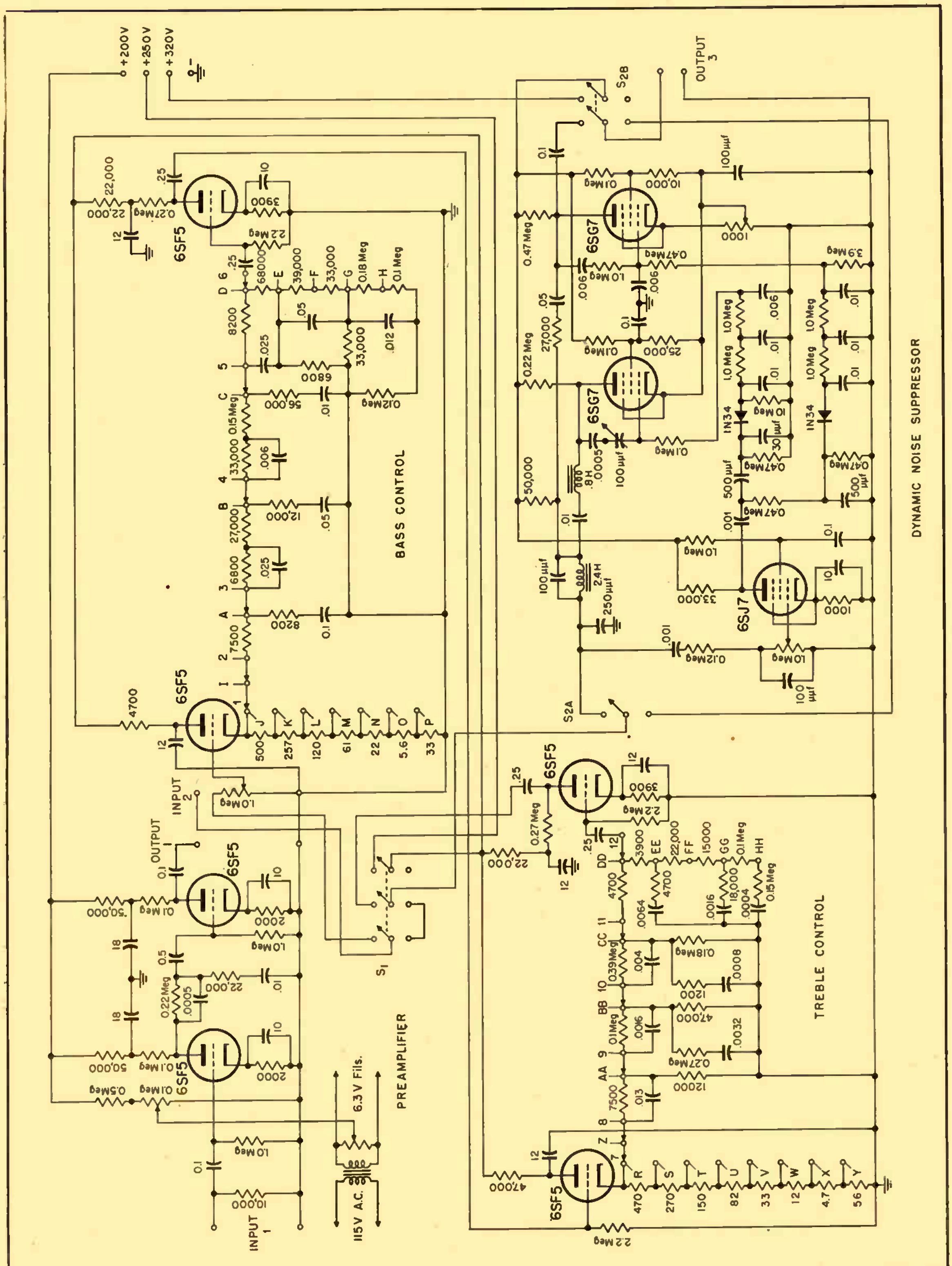


Fig. 8. Schematic of complete input equipment, with dynamic noise suppressor and modified preamplifier. Letters and numbers referring to circuit points are connected to switches, and table of Fig. 10 shows connections to obtain various response curves.

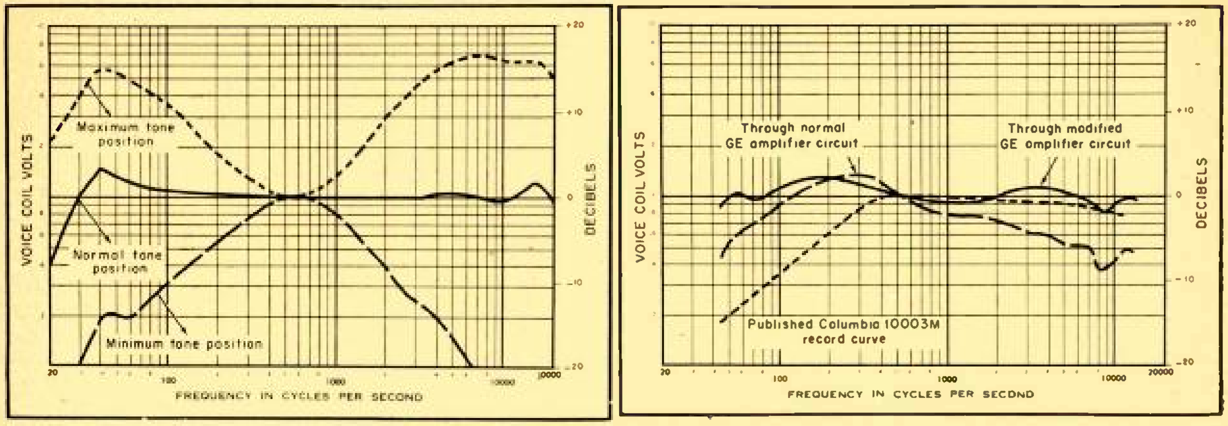


Fig. 5 (left). Range of control possible with tone controls. Fig. 6 (right). Frequency-response of normal G-E preamplifier and of modified circuit. Curve of record characteristic shown for comparison.

switching system, the preamplifier, and the power amplifier are described, and performance data is given.

The Power Amplifier

The power amplifier consists of a 6SJ7 pentode stage driving two 6L6 beam power tubes in push-pull, class A. A conventional 6J5 phase inverter is used. The output transformer is a UTC type LS-57. Its secondary is connected to four speakers thru a switching system in such a way that a variety of selections is possible. One of these speakers is in another room. The load impedance is held essentially constant thru the use of substitute resistors. A fifth speaker is connected only to the TV receiver. In this way TV programs can be put thru this amplifier or played separately thru a separate amplifier and speaker.

The circuit for this power amplifier is shown in *Fig. 2*. Negative feedback is secured from the 30-ohm output transformer winding back to the 6SJ7 screen grid thru the capacitor C_1. The capacitors C_2 and C_3 provide the proper feedback voltage division on the screen grid. Resistor R_1 and capacitor C_3 are adjusted for minimum hum and were selected by experiment using a 2-megohm potentiometer for R_1 and a capacitor decade for C_3. Positive feedback is secured through two tuned resonant loops connected between a 6L6 cathode and the 6SJ7 cathode. It is *essential* that the positive feedback be connected at a point ahead of the negative feedback return. Otherwise, maximum reduction in generator impedance *cannot* be obtained by using positive feedback in conjunction with negative feedback. One of the positive feedback loops is tuned to a high audio frequency, and the other is tuned to a low audio frequency. The high-frequency feedback circuit is tuned by capacitor C_4 and interstage coupling capacitor C_6. Capacitor C_5 and resistor R_2 are used to tune the low-frequency feedback loop. Other capacitances and resistances are influential but these comprise the components which can be readily adjusted to put the resonant frequencies at the points desired. Potentiometers R_3 and R_4 control the amount of feedback in these loops. The amount of feedback and the resonant frequency used is adjusted to provide the desired shape of the overall frequency-response curve. Invariably this has been well below the positive feedback level which causes oscillation. At the point of oscillation, extremely high peaks occur in the frequency response curve. These may be flattened by proper use of by-pass capacitors across the 6L6 cathode resistor from which the feedback voltage is obtained. A similar capacitor should be placed across the other 6L6 cathode resistor to maintain balance. Resistors across capacitors C_4 and C_5 also flatten these peaks, should it be necessary. These methods provide excellent means of shaping the basic frequency-response curve of the amplifier. At present, the low-frequency peak is set at 18 cps, and the high frequency peak is set at 20,000 cps.

After more than a year of testing and [*Continued on page 44*]

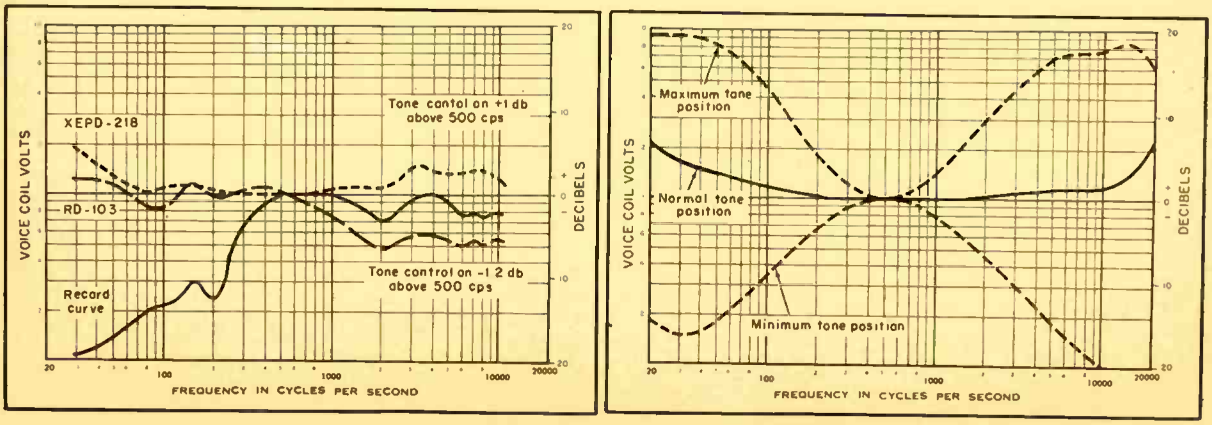


Fig. 7 (left). Response curves for RD-103 and XEPD-218 records. Fig. 9 (right). Normal and maximum curves for the equipment as finally adjusted.

An Effective Frequency Rejection Circuit

R. B. NEVIN*

A novel null-circuit arrangement designed for use as a record-scratch filter in conjunction with a wide-range amplifier.

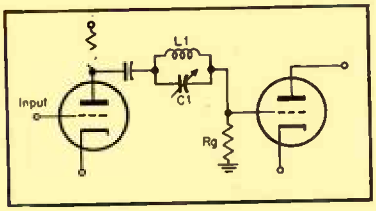


Fig. 1. Tunable rejection circuit which is not particularly sharp, and which offers several constructional disadvantages.

THE SURFACE NOISE heard from the speaker when reproducing a record is a result of a number of factors. The type of pickup, the material and shape of the stylus point, the particle size of the material (especially shellac compounds) used in the record pressing, the surface finish of both the stamper and the pressing made from it, the speaker response curve, the acoustics of the room, and the hearing range of the listener all contribute to the final effect. For any particular combination of these factors, there will usually be some frequency or narrow band of frequencies in the noise spectrum that is both obtrusive and more annoying than the other frequencies.

With the writer's present set-up, these frequencies are centered around 600 cps when playing modern shellac pressings. and the effect is more of a "hiss" than a "scratch". The pickup used is a crystal type with sapphire stylus. which with suitable equalization by an *R-C* network between pickup and amplifier input, has a substantially flat response to 10000 cps, and a usable output up to 12000 cps.

In order to be effective, a scratch filter therefore should be tunable over a range of frequencies. The usual type of tunable rejection circuit shown in *Fig.* 1. and consisting of the tuned circuit L_1C_1 in series with the grid resistor R_g of the following tube, has several disadvantages. Both ends of the inductance and of the variable condenser are isolated from ground, causing both mechanical difficulties and excessive hum sensitivity, while the inductance needs to have a very high Q if a sharp rejection is to be achieved without adversely affecting a wide band of signal frequencies. This requirement makes the filter more expensive than is warranted by the results obtainable. The *R-C* type of circuit such as the twin-T bridge, if it is to be comparable in results with a tuned circuit, requires a multiplicity of variable circuit elements and becomes rather a complex affair.

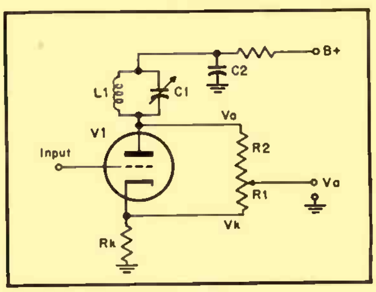
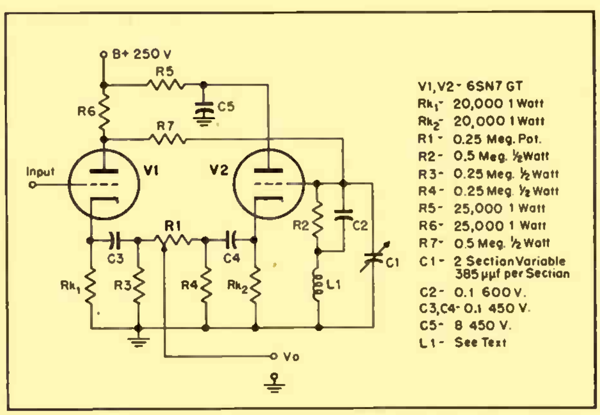


Fig. 2. Circuit arrangement designed to permit adjustment of amount of rejection as well as frequency.

To obviate these difficulties, the following circuit, shown in a basic form in *Fig.* 2, was devised. The tube V_1 has a divided load, the cathode part R_k being resistive and hence having an impedance independent of frequency over the range amplified, while the plate load L_1C_1 is frequency selective. The output signal V_0 is taken from the slider of the potentiometer R_1R_2 connected between plate and cathode. At the resonant frequency of L_1C_1, the plate output V_a will be at a maximum, and exactly 180° opposite in phase to the cathode output V_k, so that there will be a point on R_1R_2 that is ground potential, and at this position of the slider V_0 will be zero for the resonant frequency. At frequencies far removed from resonance, the plate output will be very small and $V_0 = V_kR_2/(R_1+R_2)$ approx. At frequencies slightly above and below resonance, there is a rapid shift of phase angle occurring across a parallel resonant circuit, which considerably sharpens up the rejection curve, so that signal frequencies will be adversely affected only over a narrow band width. The circuit of *Fig.* 2. is not the most suitable for practical application. While the tuning capacitor C_1 can have one end grounded. the L_1C_1 connection being completed via C_2, there is still the plate current of V_1 flowing in L_1, which is also at high d.c. potential to ground. Also, unless R_k is of a high value, there is some output from the plate at lower frequencies, due to the resistive impedance of L_1. Damping of L_1C_1 by the effective anode impedance of V_1 is not serious, due to the negative current feedback effect from R_k, but it is preferable to drive L_1C_1 from an approximation to a constant-current source.

The modified circuit of *Fig.* 3 has a more satisfactory performance, and

Fig. 3. Preferred circuit for rejection of a desired frequency, arranged for practical construction.



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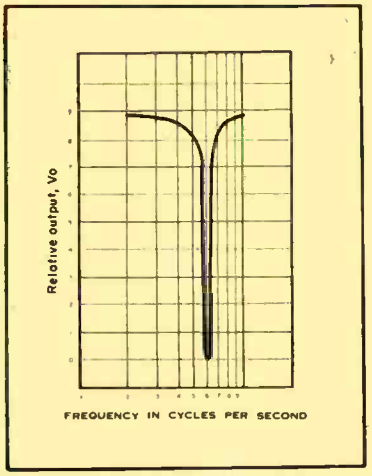


Fig. 4. (A) Relative output of circuit of Fig. 3.

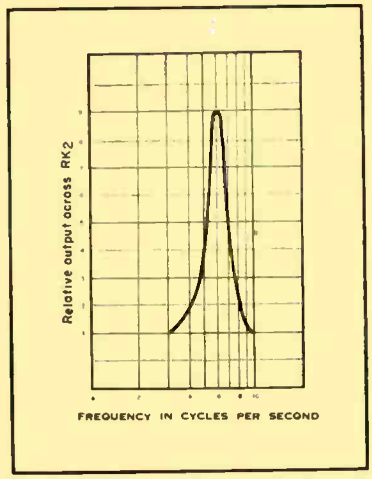


Fig. 4. (B) Output from cathode of V_2 in Fig. 3.

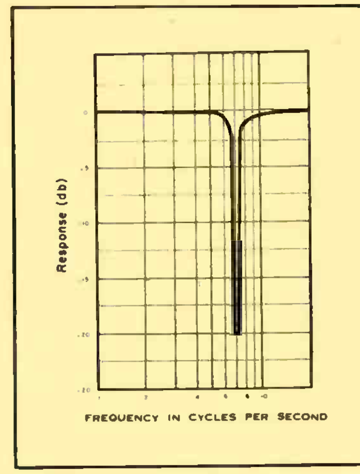


Fig. 5. Response of circuit of Fig. 3, plotted in db.

gives a low impedance feed to both ends of R_1, while both L_1 and C_1 can have one terminal grounded. The components C_3, C_4, R_3, and R_4, though not strictly necessary, are inserted to prevent noiseness of R_1, that may result due to current flow if connected directly between R_{k1} and R_{k2}. The resistors R_6 and R_7 supply grid bias for V_2, while C_2 and all stray capacitances form part of the L_1C_1 circuit. It has not been found necessary to shield L_1 or C_1, there being no audible hum pickup by either component, when the level of the output signal has a maximum of approximately 0.5 volts.

Owing to the non-availability of toroids and such like, so plentiful in the United States, L_1 was made up by winding sufficient turns of No. 30 B. & S. enamelled copper wire on a small alloy core of E and I laminations, assembled in two complete blocks with a 1-mm air gap, to give an inductance of approximately 1.5 H. This coil tunes from 5000 cps upwards with a two-section variable capacitor of 385 µµf per section. Final setting of the frequency range is made by adjusting the width of the air gap in the core. The resulting inductance has a rather low Q, as shown in *Fig.* 4(B), where the resonance curve at 6000 cps of L_1C_1 measured at the cathode of V_2 with R_1 disconnected, is compared with the curve of *Fig.* 4(A) obtained from V_o when R_1 is set to a position of complete rejection for 6000 cps.

The improvement that is possible over a simple LC rejection circuit is well illustrated, the effective Q of the tuned circuit being considerably increased. The higher the Q of L_1, the sharper will be the initial curve for L_1C_1, so that excellent results should be obtainable with a suitable inductance of high Q.

Figure 5 shows the response in db with R_1 set to give a rejection of 20 db at 6000 cps.

If the cathode loaded circuit causes too much drop in signal level, then both tubes can be plate loaded as suggested in *Fig.* 6, V_2 having an unbypassed cathode resistor for degenerative feedback.

It is possible that the employment of negative feedback taken from V_o to a preceding stage would make the rejection band even narrower, but it would require exact setting of the null point, since the output at resonant frequency on the R_{k2} side of the null point is of such phasing as to give positive feedback.

A suggested application of the circuit is the use of it as a frequency-selective element in a negative feedback path to give a peaked amplifier of higher selectivity than would be obtainable with a given L-C circuit, and at the same time retaining the advantage of requiring only one variable circuit element for frequency setting. Such an amplifier could even be made regenerative to give an increased gain and selectivity by advancing R_1 slightly past the null-point and towards R_{k2}.

Operation as a Scratch Filter

The method of adjustment used by the writer is to back off R_1 sufficiently to be able to set C_1 to the required frequency. On either side of the correct setting there is a noticeable accentuation of the "hiss" level, and by slight adjustments of R_1 and C_1, a point can be found where only the lower frequency scratch is apparent.

The effectiveness of the circuit is best judged by setting it to the null point for the most annoying frequency component of the scratch heard when playing a passage recorded at a low level, and then advancing R_1 right to the R_{k1} end, while at the same time keeping the audio level approximately constant by adjustment of the volume control. There will be apparent a quite noticeable alteration in both level and tone quality of the scratch frequencies.

As a non-technical listener remarked, with the unit in operation "the music (especially the violins) seem to ride above the scratch" whereas, without it, the opposite appears to happen, so that the scratch and hiss especially at low levels, are quite dominant.

R_1 can be set finally at any point between the null point and the R_{k1} end, depending on the amount of suppression desired.

[*Continued on page 32*]

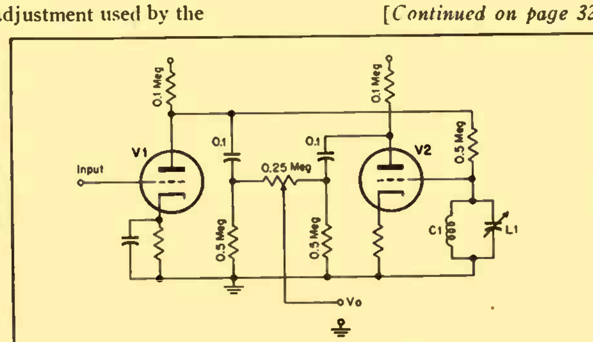


Fig. 6. Arrangement of circuit for greater output of rejection circuit.

The Terminal Impedance Of An Attenuator

HERBERT I. KEROES*

Part II. Continuing the presentation of simplified methods for determining characteristics of attenuators in audio circuits.

A NOMOGRAPH was given in Part I which relates the terminal impedance of an attenuator to the terminating impedance, image impedance, and decibel loss. The nomograph was restricted in use to resistive impedances. A large class of impedances encountered in audio work, particularly those associated with electro-mechanical transducers such as speakers and phonograph pickups, vary over wide limits within their rated frequency range. A graphical means in the form of a circle diagram, is now given to assist in the calculation of an attenuator terminal impedance when the terminating impedance is appreciably reactive.

The circle diagram is applicable to the general case of finding the input impedance of any four-terminal network with specified attenuation and phase constants, and with any type of load. As such it may also be used to compute with good accuracy the terminal impedances of filters and equalizers.

* *Acro Products Company, 5328–30 Baltimore Ave., Phila. 43, Pa.*

Use Of The Chart

The chart given in *Fig.* 1 is composed of two families of orthogonal circles, one of constant magnitude and the other of constant phase. The chart is used in much the same way as a table of logarithms, the terminating impedance data being applied to the chart and values read from the circular coordinates. Operations are performed on these values, and the results are again referred to the circular coordinates. The final values of terminal impedance are then read from the real and imaginary axis of the chart.

To use the chart proceed as follows:

1. Divide the terminating impedance by the rated impedance of the attenuator, and locate the point on the chart at which these values occur.
2. Read from the circular coordinates the magnitude of the quantity W and its phase angle.
3. Divide the magnitude by W by the power ratio of the attenuator and call this W'. The power ratio of the attenuator is given by the expression *antilog db/10*.
4. Locate the point W' at the original phase angle on the chart. Read off the terminal impedance ratio from the real and imaginary axis of the chart. The numerical value of the terminal impedance can now readily be found by multiplying the ratio by the rated impedance of the attenuator.
5. If the ratio of terminating impedance to rated attenuator impedance is less than one, take the reciprocal and proceed as above. The result in step 4 will then be the ratio of attenuator impedance to terminal impedance.

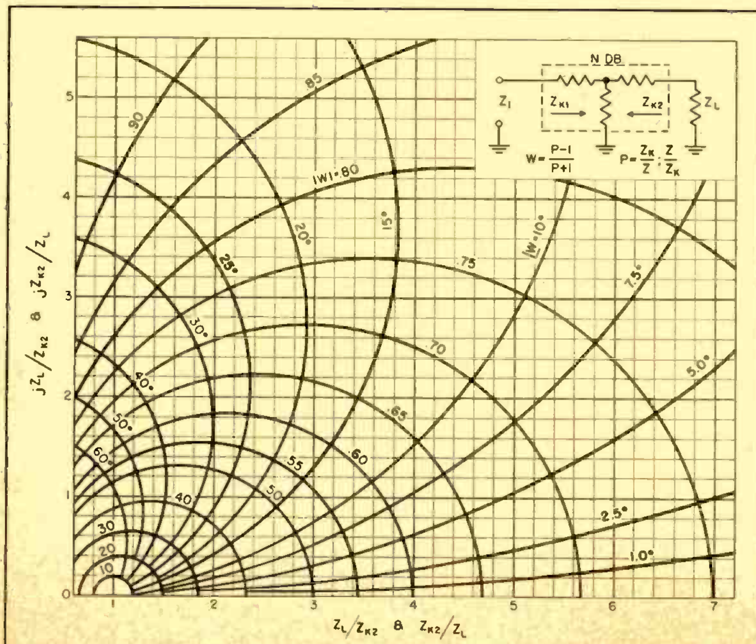


Fig. 1. Circle diagram for solution of problems involving attenuators having appreciable reactive impedances.

Approximate Solution

When the magnitude of mismatch between the terminating impedance and the rated attenuator impedance is small, a solution by means of the chart will be subject to considerable inaccuracy, since the readability is poor in the region of unity impedance ratio. If the mismatch is no greater in magnitude than about 20 per cent a good approximation may be made by direct calculation in the following equation:

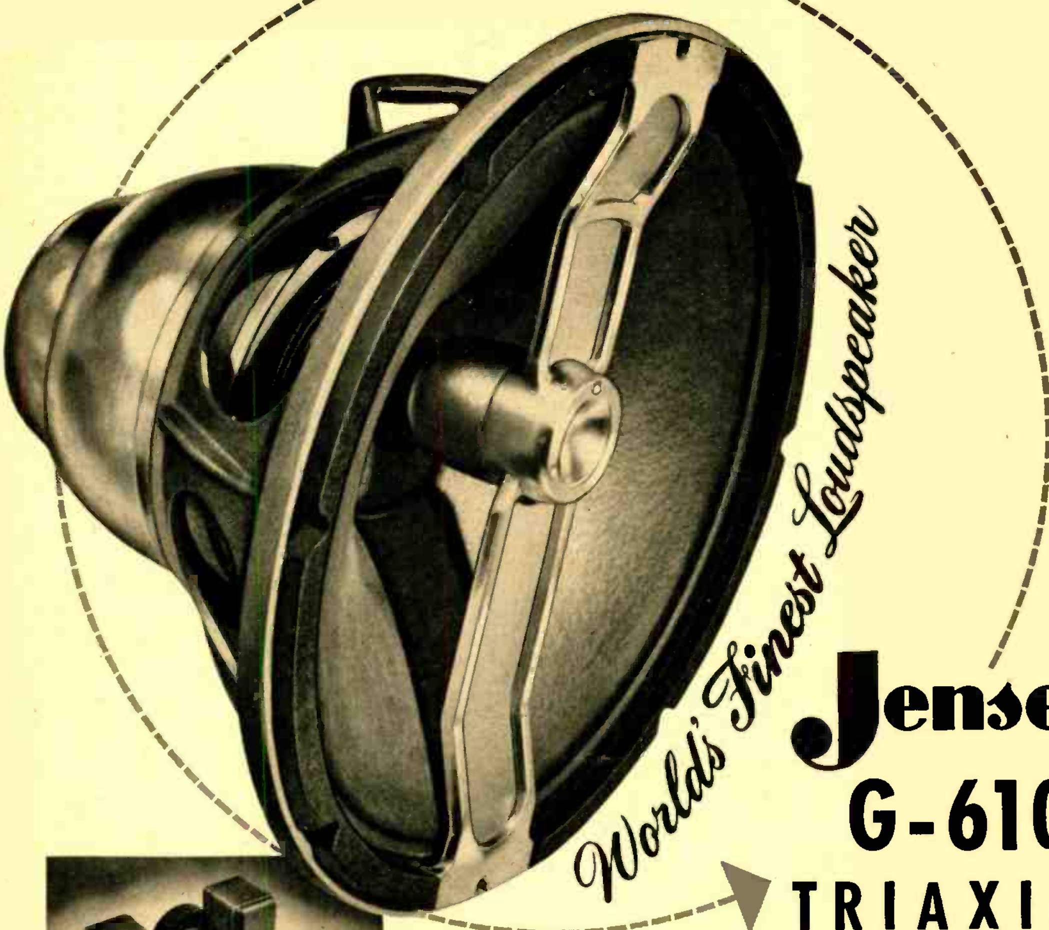
$$\frac{Z_1 Z_K - 1}{e^{2\theta}} + 1 = Z_2/Z_K$$

Z_1 = terminating impedance
Z_2 = terminal impedance
Z_K = rated impedance of the attenuator
$e^{2\theta}$ = Antilog db/10

Application

Let us consider the use of the diagram in the following example. It is well known that a beam tetrode amplifier without feedback and operating at a high level may distort badly when mismatched into a load. There are two reasons for this. First, the condition for maximum power with minimum distortion is determined by locating the load line so that it intersects the knee of the tube characteristic curve. In order to do this the load can vary only a small amount from its nominal value. Secondly, if the load is reactive, the load line becomes an eclipse which will carry operation into the nonlinear region of

[*Continued on page 43*]



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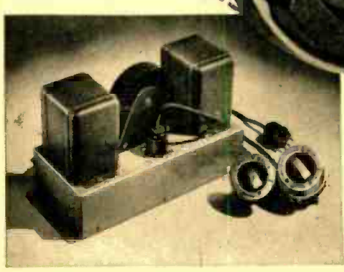

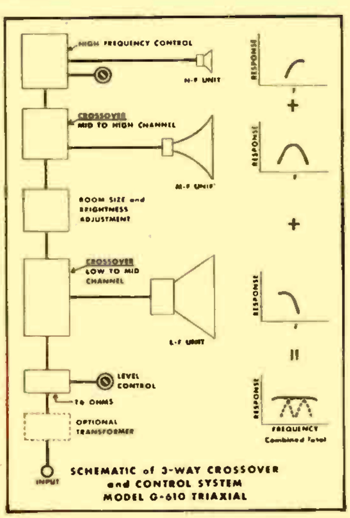

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Section Officers and Meeting Data

SOCIETY MEMBERS throughout the country are often in doubt as to the meetings held in their various localities, and occasionally write the Secretary for information. Presented herewith is a listing of the section officers, together with the dates and places of meetings in those cities where regular meeting places are available or when such information has been furnished. Members in vicinity of these cities are invited to write the Section Secretary for further information about meetings, membership, or other Society matters.

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Fundamentals Group, 4th Wed.

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Meeting places not listed will be published on this page as soon as definite information is obtained from the various sections.

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.

★ **Wanted:** Audio Technician, thoroughly experienced, to be chief engineer of two professional-grade recording studios. Prefer man not subject to draft. State salary. Box 201, AUDIO ENGINEERING.

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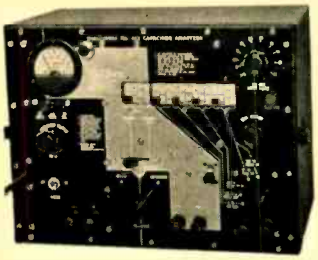
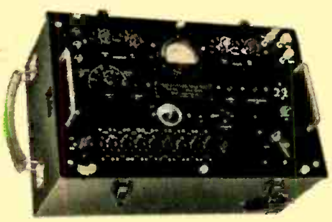
● **Sales Promotion,** advertising, publicity, public relations man now employed by audio equipment manufacturer wants change. Prolific writer of articles, sales literature, and technical manuals; engineer with merchandising sense. Age 30, married. Box 204, AUDIO ENGINEERING.

Something New



WIDE-RANGE, DIRECT-READING CAPACITOR ANALYZER

A laboratory-type Capacitor Analyzer meeting the need for a highly accurate, wide-range, direct-reading measuring instrument capable of determining the essential characteristics of capacitors has been announced by the Shallcross Manufacturing Co. This versatile instrument will determine capacitance values between 5mmf. and 12,000 mfd.; insulation resistance from 1.1 to 12,000 megohms; also leakage current, dielectric strength, and percentage power factor. A divided panel carrying an outline of the operating instructions makes it readily possible to use the instrument without reference to an instruction book. The Shallcross analyzer operates on 110 volt, 60-cycle alternating current. Literature giving full details will gladly be sent on request to the Shallcross Manufacturing Company, Collingdale, Pa.



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In addition to measuring the electrical characteristics of telephone lines and equipment the new Shallcross multi-purpose transmission test set may be used for efficiency tests on local and common battery telephone lines and sets, carbon microphones, receivers, and magnetic microphones. It also provides a fast, efficient means of testing capacitors, generators, ringers, insulation resistance, dials, and continuity. Key switches and dials are used to select and control the test circuits. The 693 Transmission Test Set is powered by external batteries. It features compact, substantial construction and is fully portable, thus making it ideal for either field or laboratory use. Details may be obtained from the Shallcross Manufacturing Company, Collingdale, Pa.

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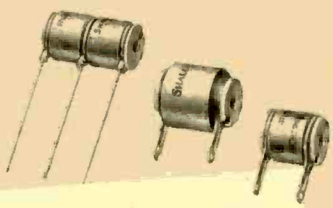

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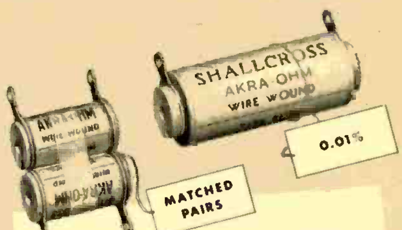

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RECORD REVUE

EDWARD TATNALL CANBY*

Spinach or Asparagus

LAST SPRING this department took time out to emit a lengthy gasp concerning the flood of new LP records and of LP record companies—and to trumpet a warning or two anent quality. Predictions of an ultimate end to the semi-runaway inflation in the LP business have yet to come true, I will have to admit, somewhat dazedly. The upward spiral—new companies, expanding LP lists, more extensive delvings into hitherto unknown and unheard musical areas—still rolls around. New records still arrive in overwhelming numbers, such as can scarcely be touched upon here, and my all-too-human reaction has been to write each month more than can possibly be published, only to have the "over-matter" held until a later month! In spite of risen prices, the LP flood was, as of the end of this last year, greater than ever.

But more than ever, I'd say that given 100 per cent peace-time conditions, a retrenchment, towards a more stable, smaller output, with more and healthier competition resulting in more carefully selected lists, better played and better recorded music, would be inevitable. Given the present and future international difficulties, we can be reasonably sure that the LP flood is due for a recession of considerable proportions. As a matter of fact, I'm sure many a company could live healthily off the best of its present catalogue for as long as records can be made!

Indeed, this may be the way of beginning of the retrenchment—for shortages as of this writing are beginning to be felt and by publication time may be a lot more serious. Vinylite first of all, of course. But also many a more obscure necessity, such as metal for plating. As has been said before, we can always fall back on asphalt, but you can't even press asphalt records without the plating metal to make masters.

So, in the midst of the greatest flood of recorded music ever, it would behoove all of us to think of scarcity and think very hard—both manufacturers and buyers of the product. A certain amount of retrenchment will clear out the noxious weeds in this particular flower garden and I, for one, am all for it. I would be only too glad to see the hundreds of sloppy, hastily contrived LP offerings that now abound suddenly withdrawn in favor of stronger material. It hurts to see murder being got away with, right in front of one's nose, and for good cash. So the first results of retrenchment are going to be good.

After that, not so good. Perhaps terrible. Because, if I know human beings at all, we can expect the canny record makers to withdraw not only the sleazy records but also the valuable, beautifully done ones that happen to have less universal appeal than some more conventional items. The unusual being the *forte* of the LP record, this will be a dismal stage indeed for us to reach. I'm only hoping that the dictates of the LP situation itself will persuade the makers to hang onto the unusual items as long as possible.

A lot will hinge, we may be sure, on possible substitutes (other than sawdust and carbon black) for pure vinylite. With small grooves in the fore, our troubles are going to be in the pop and crackle and swish category rather than in the loud hiss of shellac days. The LP record of the near future may well sound like a merrily burning wood fire at ultra close range. That is, unless somebody finds a good plastic that can be made from spinach or asparagus.

Enough of this highly risky speculation—a month or more before publication, which in these times is as good as years. Let's revel in the status quo, the LP flood, for as long as nature and man allows it to flow. But treat your records with care and watch those diamond points, my friends. That scratch you make today may still be ticking ten years from now. A real collector's item, too, no doubt.

RECORDS

Special note: Peter Bartok, of Bartok recordings, is now pressing LP records that, he claims, test flat to 15,000 cps—this in the pressing. Too late to include here, but keep an eye and ear open for them. Fine test material, from brief playings I've already heard. The music? Plenty modern, and plenty noisy, ideal for hi-fi! Bartok, and good stuff, too, though hardly of the background music variety.

[*Continued on page 33*]

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

Pops

RUDO S. GLOBUS*

HALF THE TIME, when I sit down to write this job, I don't really know whether I'm staying in my own territory or wandering into some other Joe's back yard. Certain nosy people have forced me to do a column on "folk music," and do it I will. Whether "folk music" is popular music or not doesn't matter any longer now that everybody from Patti Paige to Frank Sinatra have claimed it for the ever-loving juke box crowd. But to get down to brass tacks. . . .

Several years ago, I met one of the folk music pioneers in this country and listened enthusiastically to tales of the musical possibilities floating around through the Kentucky Hills, West Coast migratory camps, and the like. He was engaged in laboriously recording the stuff in its natural haunts for his private collection and not trying to make an industry out of it. At that time he was blissfully happy and didn't have a care in the world. During the past year, I met him again and listened to his tale of woe, which went something like this:

"Everybody's getting into the act. Folk music is fashionable now and will peter out shortly like any other fad. They crowd in to hear Burl Ives and wear blue jeans, dance Virginia reels and make like corn-fed hicks. But it's all affectation, and the one big chance to make folk music everybody's music will go right out the window."

Bitter and disillusioned, friend enthusiast has gone commercial, deciding that if anybody should make a buck out of the folk fad, he should. I won't mention his name, because he's a good joe and should be left alone to cry bitter tears into bitter beers. But, this problem is a very real one and should be tackled. Let's face it squarely.

A few years ago, my wife and I spent a pleasant afternoon picknicking with some

[*Continued on page 28*]

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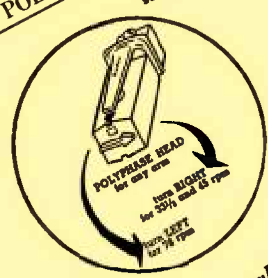

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POPS

[*from page 26*]

friends of European origin. After food had been digested, they began singing European folk songs, all lovely and with a general quality of pleasant camaraderie. After they had exhausted themselves, they asked us to sing some American folk songs. I pretty well knew the lyrics of "Tea for Two," and vaguely remembered parts of "A Tisket, A Tasket." My wife could do a splendid job on some nursery tunes and an occasional line or two from "I've Been Working On the Railroad." Not a very impressive collection of folk songs, and decidedly inferior to the European equivalent. We both knew that there are thousands of American folk songs, but had never been in close-enough touch to really make them part of our melodic vocabulary. The moral of the tale is obvious. This country has an enormous folk music heritage, which is localized and maintained as a vested interest on the part of a few connoisseurs. Instead of every child learning them at his mother's knee or hearing them in school, the average child's repertoire consists of the biggest collection of trashy children's songs and infantile pop ballads that ever grew out of a lunatic's musical ravings.

To make matters worse, we are now being exposed to sundry groups like the "Weavers" and pop singer's version of jobs like "The Tennessee Waltz" . . . all on a pop level, with full rich orchestrations and all the rhetorical mannerisms typical of big time show business. Despite the fact that capable people like Alan Lomax have done magnificent documentary work, there is no real folk music root in American musical culture. The Library of Commerce has some excellent documentary recordings of the legitimate stuff, available for a small fee, but the effect is not noticeable. You can't teach people to like folk music, especially when they are forced into believing that it is the exclusive property of glamorous stage, screen, radio, TV, and recording personalities. In addition, with few exceptions, the documentary folk music has been badly recorded from the point of view of creating an illusion of presence, vitally important for folk music participation. You cannot force people to like folk music, period. But there are thousands of people who would develop the strong affection for folk music typical of the average European, if they could come to grips with it on the necessary direct level.

If you eliminate the glossy and vulgar stylizations typical of the present trend and record the stuff from a non-educational, non-anthropological, non-historical point of view . . . simply for a good listen and a feeling of closeness to the stuff of a national folk lore, you might begin getting somewhere. The Library of Congress venture was a good start, but a more substantial job is necessary to wash our mouths of the glamour treatment. In every community in the United States, there is a folk music source. We need not limit American folk music to the Kentucky Hills, the cow country of Texas, or the hill-billy songs of the Southern and Western United States. The recording of the folk music shouldn't be a vested interest of the commercial record manufacturers, and really needn't be any longer. With a plethora of efficient portable tape recorders available, any individual can start building up a library. In addition, if he happens to have somewhat of a background in recording technique and an awareness of the acoustic psychology involved, he can do a better job than has been characteristic to date. If he should want to put it on records, he should be interested enough in the idea of starting a National Folk Music Archive. A collective pool of moneys would enable the selection of the best material for permanent recording and national distribution on a non-profit basis. The idea isn't original, but should be thrown into the laps of the audio engineers who have both the equipment and the requisite know-how to do the job correctly.

Seven years ago, I heard one of the most magnificent examples of folk balladry in the town of Rockford, Illinois. Sung on a street corner by a blind guitarist, the song had all the pathos and naive insights typical of good folk music. As far as I know, nobody was on the spot to record it and nobody showed sufficient interest to try and produce a repeat. If you want your kids to do better than a tired version of "Rudolph the Red Nosed Reindeer," or you're getting tired of the trillionth chorus by you, your wife, your family, etc., of "Rambling Wreck from Georgia Tech," get busy! It has to be done on the spot, without the benefit of heavy orchestrations or phony studio technique . . . and it has to be done by the people who know that a microphone isn't the answer to a bad case of laryngitis.

NEW RELEASES:

I'll Be Seeing You, Tallulah Bankhead
Columbia 39109

It is only fitting that the first release on this month's list be the above-mentioned little joy. If it were equipped with a narrator and a few children's cartoons, it might be classified as an addenda to Tubby the Tuba, called "Tallu the Schmoo." I have never listened to a record with a more compulsive desire to request the vocalist to please clear her throat. This gravel-throated, rhetorical singer of folk songs is none other than the little darling who heads the N.B.C. extravaganza, "The Big Show," and has been seen occasionally garnishing some of our better stages. Miss Bankhead has all the necessary equipment to sing sea chanteys, but hardly the nostalgic balladry of Tin Pan Alley. With a certain similarity to our own Marlene Dietrich, her version of the ditty makes perfectly legitimate a question, to wit, did Columbia record a screeching chair in the background while the eternal Bankhead was learning her lines? She is accompanied by Joe Bushkin who is being raved about by all the better people, but who is merely a cute pianist in this reviewer's book. If you must buy this disc give it to your little ones. It is a fitting replacement for the usual birds and bees lecture and will harden their little arteries painlessly. Without any hesitation, the worst record premiere of ill fated 1950.

Swing Session,
Edmond Hall and Teddy Wilson
Commodore FL 20,004

This is the hardest LP to review of the hundreds that have crossed this path. It is a record that I vehemently urge every reader of this column to buy, but is requires some careful reservations. It is technically poor. The clarinet is over-recorded, the surface is occasionally brittle, and the over-all balance leaves quite a bit to be desired. But musically, it is one of the really great jazz collections on LP. Featuring the "Edmond Hall Quartette," composed of Edmond Hall, clarinet, Teddy Wilson, piano, Billy Taylor, bass, and Arthur Trappier, drums, it is a joy to listen to.

Hall and Wilson are two completely different jazz stylists; Wilson plays a more-or-less sophisticated jazz piano, while Hall belongs in the tradition of the more naive but infinitely wise jazz men of the heroic age of jazz. Put them together, and you have some of the most exciting moments in jazz. "Show Piece," one of Hall's own compositions, contains one of the great jazz clarinet solos on record. Completely a jazz tour-de-force, it reveals Hall as one of the really top men with a horn. "Sleepy Time Gal" and "Where or When" combine Wilson and Hall in a patter, one against the other, high-lighting the noble aspects of each other's musical genius. "Night and Day" is high-lighted by the primitive, naive, but oh so wise, improvising of Hall with the unbelievably perfect pianism of Wilson filling in and soloing. It is a tragedy that this disc couldn't have been recorded perfectly, but it manages to get by sufficiently well to make it obvious how good each band is.

Manhattan Moods
Morton Gould and His Orchestra
Columbia ML 2144

I can take Gould or leave him alone. Occasionally, his orchestrations are nothing short of ingenious and he manages to get a sprightly sound out of the massive tonal effects. This is one of the better jobs and should appeal to those who get nostalgic for New York. Included are versions of such standbys as "Manhattan Serenade," "Street Scene," "Park Avenue Fantasy," etc. The recording job is pretty much in line with the extra-good work that Columbia has been turning out during the past year. If you like rich, but tasty, orchestrations of "New Yorkese Music," well played and well recorded, this should be your baby.

Anything Goes Mary Martin
Columbia ML 2159

Columbia has come along with an excellent idea and has carried through all the way. They have taken the highlights of one of Cole Porter's best scores, assembled a decent sized orchestra and chorus, and with Mary Martin's ever-loving voice leading the way, pressed a snappy version of a worthwhile musical. Arrangements by Ted Royal are extra good, and the recording itself is excellent. In case you've forgotten, the score includes "You're the Top," "I Get a Kick Out of You," and "Blow Gabriel Blow." Unlike the usual stew of old show tunes, this is live-live stuff beautifully conceived and produced. Definitely on the "must buy" list.

The Bandwagon Mary Martin
Columbia ML 2160

Same idea as above. The Arthur Schwartz musical is done up proud, with excellent arrangements of "Dancing in the Dark," "I Love Louisa," and "Where Can He Be." Lehman Engel, an old hand at this sort of stuff, leads the orchestra and chorus. Only criticism would involve the overpowering effect of the orchestra and chorus at spots. Mary Martin has a noble pair of lungs, however, and manages to outblast them all.

Originals by Alvy West and The Little Band
Columbia CL 6062

A few years ago, a small group of musicians left the West Coast and came East with a trunk full of catchy arrangements and a general virtuosity which caused quite a stir. I haven't heard much of them lately, but wish them well wherever they are. They are now immortalized on LP with a potpourri of their best stuff. The Little Band is a sextet consisting of Robert Caudana, accordion; Larry Neill, trumpet; Louis Paonessa, drums; Trefoni Rizzi, electric guitar; Arthur Shapiro, bass; and Alvy West, leader and saxophonist. There is no way of describing their stuff. It isn't the usual small group combo; it isn't a jazz organization. They're fun to listen to and, if my feet serve me well, make a satisfactory background for dancing. "Tony's Guitar," "Mom's Song," "Blue Rhumba," and "Cathy" are highlights of this ten-inch disc. Columbia has done a noble job of recording, especially in terms of acoustic depth. If you listen to a whole batch of the recent Columbia's, it is immediately noticeable that acoustically each record is treated individually. Echo is not used as a permanent characteristic, but is modulated to suit the demands of the matter being recorded. Whoever is responsible deserves a "Well Done!"

Raymond Scott's Drawing Room
Columbia CL 6083

Just to prove that Columbia isn't perfect, we can drag out this LP in rebuttal. If you don't remember Raymond Scott, the zany arranger, it might be worth taking a listen to a few bands on this disc. Most of the important things are on it, including "Peanut Vendor," "Boy Scout in Switzerland," "Toy Trumpet," "Powerhouse," and more of this ilk. These are all dubs, of course, and nothing to be proud of. Surfaces are brittle and occasionally noisy. The original recordings had as much acoustic depth as a flat-chested wolfhound and balance is occasionally ridiculous. The Quintet recordings are somewhat better than the large orchestra's, but neither passes muster. If you are interested in progress in the record business, compare the Alvy West recordings (reviewed above) with this one. Both are small groups playing comparatively similar stuff.

Hot Trumpet Ensembles
Mercury MG 25074

If my memory stands me in good stead, this is a dub of old Keynote recordings of small groups featuring horn men such as Roy Eldridge, Charlie Shavers, Emmett Berry, Joe Thomas and Jonah Jones. The only reason that I'm bothering to review this is to point up the old lesson, much of which I've forgotten. The stuff is mostly dull, undistinguished jazz. The recordings are so bad that I wonder why Mercury even bothered to dub this stuff. Performances of the "St. Louis Blues," "Don't Be That Way," and "El Salon de Gutbucket," are the least interesting on record. The market is literally flooded with second-rate dubs of so-called jazz classics. The money could be more wisely invested in other directions. We are faced again with the old problem of putting collections such as these on LP. Even if the stuff is bad, it should be disc'd on either 45 or Tiny Tim LP to give the buyer a break.

Gene Krupa Dance Parade
Columbia CL 6066

One of Columbia's "Dance Parade" series, this one does nothing much to me. It contains Krupa trio recordings of "Stompin' at the Savoy" and "Body and Soul," both replicas of the performances originally released by Disc. Charlie Ventura is on sax and Teddy Napoleon on piano, thereby giving me another excuse to plug the great original recording on 12-inch Disc, still available if you hunt for it at jazz collector's shops. The recording job brand new, utterly unknown Haydn, beautifully performed—music that is top rate listening and top rate in artistic value and in these later Haydn Society recordings, absolutely top rate from the recording and processing angle. Most of the music has been known on paper but seldom played; the "Melk" Concerto—dug up only last year after nearly 200 years of vanishment—and the string of 24 dances for the famous Imperial Dance Hall, the Redoutensaal, make top rate new recorded music that was not even known to exist on paper a few years ago. The Bach and Vivaldi-Bach works are often heard in piano versions—utterly confused and messy, since pianos blend too well (minus color overtones); you'll probably never hear four harpsichords together again, let alone three; but the results here are what count—the sharp, highly colored harpsichords come through perfectly distinctly and every note can be heard as never on the piano. A lovely recording, too, as are all of these.

Pardon my enthusiasm for these Viennese recordings—but I'm honestly convinced that they represent the most memorable musicologist-performer-engineer collaboration of this century and I expect to get untold hours of additional enthusiasm out of the continuing series—Westminster and Haydn Society—in the coming months. Only one word of warning: the earlier numbers in both series (they are issued in order) were not as well recorded and often rather badly processed, with overcutting and quite some distortion, on wide-range equipment. Anything over WL50-10 or so and Haydn Society HSLP #1010 should be OK. (Some may well have been re-processed for later editions than the review copies I got.)

Piano

Schubert, "Wanderer" Fantasy, op. 15; Four Impromptus. Orazio Frugoni.
Vox LP: VL 6690

Schumann, Fantasiestücke, op. 13. a) Arur Rubinstein.
RCA Victor 45: WDM 1335 (3)
LP: LM 1072 (½)

b) Jacqueline Blancard.
London LP: LPS 210 (10")

Chopin, Five Nocturnes. Maryla Jonas.
Columbia LP: ML 2143 (10")

Chopin, Four Ballades. Robert Casadesus.
ML 2137 (10")

Chopin, Twenty Four Preludes. Guiomar Novaes.
Vox LP: VL 6170

Chopin, Fourteen Waltzes. Alexander Brailowsky.
RCA Victor LP: LM 1082

Piano is still the most difficult medium to record and the weakest element in any argument that compares LP to 78. No doubt about it, those who stick by the 78 record have strong points in their favor when it comes to piano—few piano LP's have proved themselves against the formidable backlog of 78 competition, running back 20 years or more; plenty of piano LP's are just plain bad and from the biggest companies, too.

"Hi-fi" in the usual sense of wider tonal range is unimportant in piano because the instrument has relatively few higher overtones except in the transient phase—the percussion—compared with other instruments and voice. What counts most of all is an absolutely even speed—and LP is clearly at a disadvantage here in that very high standards are necessary to achieve the desired sound. Some irate correspondents of mine will not agree when I say that piano on LP *can* be good! They are right in saying that many LP's have poor piano sound from the musician's viewpoint. (1) Waver—often painful—from either the tape machine or the LP cutting table or from off-center pressings. (2) Thin, insubstantial bass, poor transient sounds. (I would doubt myself if this is inherently the fault of LP as such.) (3) Unnaturalness due to bad mike pickup and acoustics—which, of course, is actually no fault of the LP process but gets blamed on LP by angry record buyers.

What *is* good piano? Engineers and musicians disagree more thoroughly here than anywhere else. I cite the first of the above, the Schubert "Wanderer," as the musician's idea of good piano. I recommend it, especially near the end of side 1, to all piano-recording engineers for reference. Steady pitch, big, full-sounding bass, above all a natural percussiveness without the wooden or metallic thump so unpleasant in many piano recordings. A tremendous record. How is it done? My best guess is (1), a biggish, amply spaced live hall—*not* a studio; (2) *distant* mike, probably from 7 or 8 to perhaps 15 feet away.

The Schumann 45 (I don't have the LP) by Rubinstein is a thin, brilliant-toned offering, with considerable waver and bell-like distortion on some notes, an astonishing lack of bass. The same music on London LP is more natural and full, with both bass and a higher recorded level. The interpretation by Blancard is most endearing and thoroughly enjoyable; Rubinstein's is excitingly brilliant but cold. London wins on all points. If you don't believe me, try for yourself. The Brailowsky waltzes on LP (a later release) are much better in respect to thinness and waver, though the level is very low (not necessarily a liability since RCA surfaces are superb) and bass is still weak.

Columbia's piano is very interesting—for it represents perhaps an engineer's concept of perfection in technical respects. The latest recordings—such as the Chopin Nocturnes and Ballades—are quite free of peaks, sloppy transients, mostly free of waver. But Columbia hasn't satisfied the musical ear as has Vox (above) and the difference can only be in mike technique. Columbia evidently favors a close-to technique, with the mike possibly three or four feet from the piano in a large studio. Results: a hard, metallic sound, with much of the mechanical noise coming through, a lack of true singing quality, and above all a lack of the proper liveness. Too close! Matter of opinion, of course—but all piano-minded engineers should study these Columbias in an A-B test with the (Columbia processed) Vox recording.

Musically, Jonas's Nocturnes, mostly soft music, are beautifully played: the recording doesn't involve much loud playing and so sounds good. The Casadesus Ballades are the opposite—very loud, hard, unfeeling performance made doubly hard and ugly by the close-to piano recording technique. No distortion, electrically speaking, and a splendid technical job, about as ugly in sound as any piano recording I've ever heard! The Novaes Preludes, while good, do not in my copy seem to be up to the other Vox, the Schubert. Mme. Novaes' interpretation is famous: I find the preludes rather fussy with too much emphasis on the "accompaniment" figures, not enough on the melodies.

P.S. Joke on someone: Since the above was set up in proof I've discovered that the Schubert "Wanderer" recording, Vox VL 6690, was recorded by Columbia—in the New York Columbia studios. Processed and pressed by Columbia, of course, too. How come? The Vox record was taped under Vox's supervision, according to Vox's ideas of mike set-up. The Columbia-label records above were perhaps done in the same studio—but according to Columbia's own ideas of mike set-up. Perhaps my remarks have even more point? Interesting situation, anyhow. What *is* good piano?

WORDS AND MUSIC

The Candid Microphone, Vol 1. Alan Funt et al.

Columbia LP ML 4344

Saint-Saens, Carnival of the Animals—with Interpolated Verses by Ogden Nash. Andre Kostelanetz & His Orch. Noel Coward.

Columbia LP ML 4355

Increasingly—thanks to radio and TV—we're getting novel combinations of words and music on records. The Candid Mike stuff is part just plain practical joke stuff, part rather touching eavesdropping. Good for an evening's fun, at least. Remarkably good tape quality on the portable candid part. The Saint-Saens-Ogden Nash mixture is pure inspiration, both members of the team benefiting. The elephant, for instance, who's "equipped with handles at both ends" according to Nash, and played musically by the double basses. . . . A delightful record, and I only wish it had been Ogden Nash himself instead of the too-fancy Noel Coward.

NEW PRODUCTS

● **Distortion and Noise Meter.** Simplicity of operation is featured in the new Type 35-A Distortion and Noise meter recently announced by The Daven

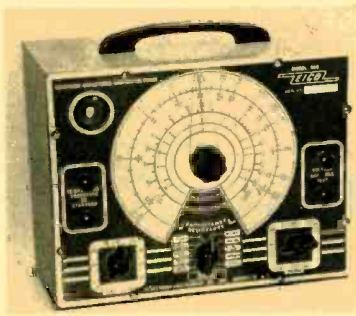
Company, 191 Central Ave., Newark 4, N. J. Not to be confused with meters employing null networks which require careful frequency and phase adjustments at each reading, the fundamental circuit of Type 35-A comprises a series of eight fixed band rejection filters covering the range 50 to 15,000 cps. followed by a stable, high-quality, wide-range, high-gain amplifier. There are no tube circuits or other sources of inherent distortion between the input of the 35-A and the filter network input. Consequently, extremely low levels of distortion can be accurately measured over a wide level range. Distortion as low as 0.1 per cent can be measured at full scale meter deflection with 0 dbm input, and noise measurements as low as -80 dbm can be obtained. A 4-page bulletin is available on request from the manufacturer.

● **Pre-amplifier-Equalizer.** Connoisseurs of fine recordings will find interest in the new Model A100 pre-amplifier-equalizer recently announced by Brociner Electronics Laboratory, 1546 2nd Ave., New

York 28, N. Y. Designed for use with magnetic pickups, the Model A100 unit provides exact low-frequency equalization for LP records as well as for all domestic and foreign standard recordings. Similar to the earlier Model A65, the new unit provides increased gain, thus suiting it for use with low-level dynamic pickups, and lower output impedance permitting use of longer output cable without loss of highs. Model A100P includes built-in power supply. The manufacturer will supply full details without charge.

● **Test Laboratory Facilities.** C. J. LeBel, audio consultant, announces the establishment of laboratory facilities for tests of amplifiers, equalizers, filters, and other audio apparatus. These services are available to individuals and organizations who have need for reliable measurements, special tests, or calibration of their equipment. For laboratory work or for further information, contact C. J. LeBel, 133 West 14th St., New York 11, N. Y. or by telephone –Ch 3-8082.

● **Comparator Bridge Kit.** Combining both economy of cost and dependability in operation, the new Eico Model 950 R-C-L bridge kit permits instant comparison of any resistance, capacitance or inductance with any similar component as a given standard. The instrument is capable of testing every type of resistor from 0.5 ohm to 500 megohms. Capacitance range is 10 μμf to 5000 μf. For leakage test a source of variable voltage is included in the unit with a range of 0–500 volts. All measurement ranges are clearly calibrated on the front panel, thus eliminating the need for external charts or multipliers. Model 950 R-C-L

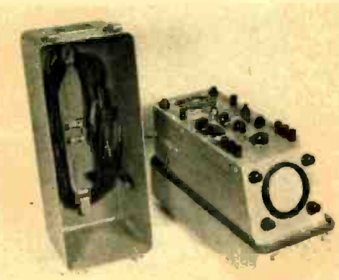


is supplied with easy-to-follow step-by-step pictorial and schematic diagrams. Manufacturer is Electronic Instrument Co., Inc., 276 Newport St., Brooklyn 12, N. Y.

● **High-Quality Amplifier.** The new Rauland-Borg Model 1810 amplifier is a 10-watt unit designed primarily for use in custom-built radio-phonographs. Three input channels, controlled by selector switch on front panel, afford choice of magnetic or crystal pickup, or tuner. Frequency response is ±1 db from 40 to 20,000 cps. Harmonic distortion is 3 per cent at 10 watts output, and intermodulation is 5 per cent. Bass control range is plus 13 db to minus 7 db at 40 cps, and treble control range is plus 10 db to minus 20 db at 15.000 cps. Compensated volume control increases low-frequency response as operating level is reduced. The amplifier is remarkably compact, measuring

only 10½ × 6½ × 6 in. overall. Full description may be obtained by writing Rauland-Borg Corporation, 3523 Addison St., Chicago 18, Ill.

● **Miniature Wide-Band Oscilloscope.** Many features normally found only in bulky laboratory equipment are incorporated in the new Hycon miniaturized

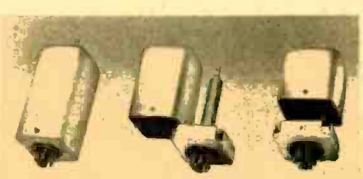


oscilloscope. Sweep frequency range is 3 cps to beyond 50 kc. Vertical amplifier response is flat within 3 db from d.c. to 2 mc. Horizontal response is flat within 2 db from d.c. to 100 kc. Incorporated in the unit are a blanking amplifier and a synchronizing amplifier, and a circuit design which maintains a sweep return time ratio of not less than 5 to 1 at all frequencies. Deflection sensitivity exceeds 0.5 volts/in. Unique is the instrument's ability to reproduce wave forms with 3 microsecond rise time, and 100-kc square waves. The instrument is exceptionally compact, measuring only 9 × 6 × 14½ in. and weighs but 17 lbs. Complete technical data available from Hycon Mfg. Company, 2961 E. Colorado St., Pasadena 8, Calif.

● **Phonograph Pickups.** Branching further into the field of audio equipment, Sonotone Corporation, Elmsford, N. Y. is expanding its line of Titone pickups to

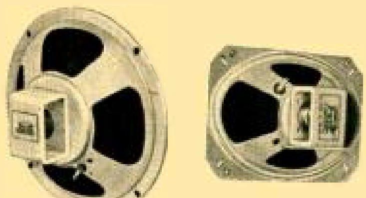
include two additional models—the Playal with replaceable stylus, and the Turnover, designed as its name implies to provide separate points for LP's and 78's. The Playal may be equipped with stylus of any desired diameter. Both pickups feature wide frequency response, low needle talk, and freedom from the affects of temperature and humidity changes.

● **Plug-In Assemblies.** A complete line of plug-in assemblies and housings for use with coils, relays, crystals and other similar components is now being produced by Dietz Design and Manufactur-



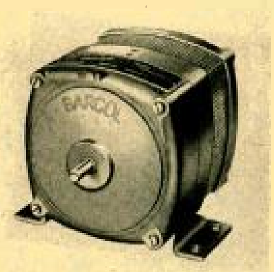
ing Company, Grandview, Mo. Desco plug-in units are made in a wide range of standard sizes, all of which are described and illustrated in a technical bulletin which will be supplied without charge by the manufacturer.

● **New Speaker Models.** Further expanding the Oxford line of loudspeakers are eight new models including two weatherproof units for outdoor application,



a pin-cushion type for auto-radio replacement, and a group of standard electro dynamics. Technical information is available on request from Oxford Electric Corporation, 3911 S. Michigan Ave., Chicago 15, Ill.

● **Reversible Motors** which can be used as single-phase induction motors, single-phase capacitor motors, or as two-phase

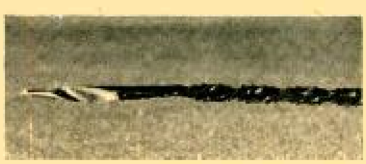


motors are now being produced by Barber-Colman Company of Rockford, Ill. Shading-coil circuits can be designed for impedance or transformer coupling to vacuum tube plate circuits.

Continuous duty ratings up to 1/50 h.p. are available in the two-phase service, and the motors are available in four different frame sizes either with or without gear reductions, open or closed. All models are characterized by high starting torque, and are well suited to servo mechanisms and remote positioning devices.

Literature and more detailed information may be obtained from Small Motors Department, Barber-Colman Co., Rockford, Ill.

● **Combination Drill and Saw.** Truly unique is the Stickleback Drilsaw, a hand tool which may be used to drill a hole and then to saw any desired shape in

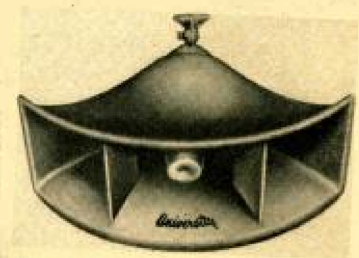


any direction. Available in a variety of diameters up to ½ in. the Drilsaw has a wide variety of potential applications for radio, TV and telephone installation men, as well as for carpenters and cabinet makers. Distributor is Tec Imports, 14404 Addison St., Van Nuys, Calif.

● **Magnetic Recording Tape.** Rounding out its line of amplifiers, recorders, and accessories, Amplifier Corporation of America, 398-4 Broadway, New York 13,

N. Y. is now distributing to jobbers a new premium-quality recording tape marketed under the trade name Magneribbon. Available in four standard types, Magneribbon is supplied on non-warping tempered aluminum 7-in. reels that fit all standard recorders. Each reel includes a metal leader to facilitate threading. All tapes are precision slit to close tolerance well within RTMA standards. Descriptive circular, including prices, may be obtained by writing direct to the manufacturer.

● **Wide-Angle Paging Speaker.** Featuring a horizontal dispersion angle of 120 deg., and a power input capacity of 12 watts continuous, the new University



Model COBRA-12 speaker offers both efficiency and economy for paging and talk-back applications. The unit is unique in its use of both a re-entrant reflex assembly and a multi-cellular distributor. Hermetically sealed driver plus heavy-gauge metals and die castings make the speaker trouble-free mechanically and electrically. Frequency response is 250–10,000 cps. Full information will be supplied by University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N. Y.

● **Industrial Dual Speaker.** Designed essentially for industrial application, the new Racon Model RR-40 dual speaker is ideally suited for installation in rail-

road stations, steel mills, factories, and other similar spots where immunity to acid fumes and easy servicing are prime requisites. Entirely weatherproof, Model RR-40 consists of a non-corrosive center aluminum casting with a steel-bell re-entrant speaker at each end of the opening. Lower cut-off frequency is 350 cps and dispersion angle is 45 degrees. Normal operating capacity is 40 watts. Full details of the Model RR-40, as well as the remainder of the complete Racon line, may be obtained by writing Racon Electric Company, 52 E. 19th St., New York 3, N. Y.

● **Adhesive Nameplate.** Metal-Cal, a new self-adhesive metal nameplate, requires no drilling of panel holes, no screws, rivets or other fastening devices, and can be quickly applied to any smooth surface on metals. Bakelite, glass, wood, paint or enamel. The nameplate is made of .003-in. aluminum foil anodized and dyed to government specifications. Permanence of markings is assured by the processing which makes them a part of the foil itself. Metal-Cal has passed rigid salt-spray, humidity, abrasion and temperature tests. Samples and complete technical data may be obtained upon request to C and H Supply Company, Metal-Cal Division, Boeing Field, Seattle, Wash.

HOLLYWOOD LETTER

[*from page 4*]

Studios were fortunate in choosing 35-mm magnetic recording stock with the 5 and 6 mil base thickness, as this base thickness prevents the "print-through" which occurs in the thinner narrow tape materials. The seriousness of this print-through was not fully appreciated at first but it becomes increasingly important with the re-running of old magnetic recordings which have been stored for long periods. Apparently this phenomena is one which progresses continuously during storage in the thinner base tapes.

The problem of setting azimuth standards has plagued the industry somewhat, but it was finally solved at one major studio in the following manner. A magnetic printing machine was built which was capable of printing a magnetic copy of a six-foot length of a recorded 9000-cps signal. As this printing was done with the magnetic material face to face, a mirror image of the original recording was obtained. It is then only necessary to adjust azimuth by means of an extended-arm vernier so that the original and the print of the 9000-cps tone peak at the same azimuth setting.

Magnetic recording facilities have simplified many of the latter steps in the preparation of a picture. These steps are commonly called "dubbing" or "re-recording." With magnetic recording it is possible to prepare many complex composite tracks for temporary use during assembly because the process is sufficiently "noise free" to permit five to six successive transfers without becoming noisy.

In addition to the magnetic recording work which is going on, several new microphones with interesting possibilities have been under test. One which has performed very well is the German Telefunken Model M7 Directional Condenser Microphone.

This microphone utilizes two gold-sputtered diaphragms and shows a highly directional cardioid pattern. The head weights only six ounces and with American type miniature tubes replacing the German pre-amp tubes, a very small light assembly is achieved. This microphone is under limited production of approximately thirty units per month in Germany at present and the last price quoted was $68 for the head only. This price is subject to some fluctuation because of the variable exchange rate. Inquiries may be directed to Mr. Gerhard Muller, Adolfstrasse #18, Steglitz, Berlin, (U. S. Sector) Germany.

Another new microphone of interest is a dynamic unit made by Philips. This model is supplied to the customer with an acoustic calibration curve of its response. This microphone is distributed by Philips representatives in this country.

AUDIO PATENTS

[*from page 3*]

plate output at higher frequencies due to stray capacitances across its high impedance. When this happens, the feedback from the upper power tube to the inverter cathode drops off as well. Since that feedback was responsible for some of the voltage going from inverter cathode to the lower power tube, input to the latter tends to drop too, aiding balance. Over-all frequency discrimination is lessened at the same time, however, because the new feedback circuit tends to keep the output of the upper power tube steady by lowering it for strong signals—the inverter cathode voltage having, of course, a strong effect on plate output.

The writer has always found inverse feedback logic the most stimulating kind of mental acrobatics, but feels it too involved to be safe with only one man in the act. Is the logic in the last paragraph correct? Contributions from logician readers are welcome!

Telephone Line Connection

Twen S. Wang of RCA has patented a vacuum-tube circuit which substitutes for the hybrid transformer used in some telephone arrangements. Mr. Wang's purpose, according to the patent (No. 2,511,948), is to couple a radio receiver and a radio transmitter to an ordinary subscriber telephone line in such a way that signals going to the line from the receiver will not feed back from the line to the transmitter.

As the circuit diagram indicates, signal from the receiver passes through an amplifier tube to a transformer, the secondary of which is connected across a two-way phone line. Signal from the line passes through an amplifier tube to the transmitter. Ordinarily, of course, the common connection of the output of the receiver amplifier and the input of the transmitter amplifier would couple the receiver to the transmitter.

Mr. Wang eliminates this coupling, however, with a third amplifier tube which couples the receiver directly to the transmitter. The signal introduced into the transmitter from this third amplifier is 180 deg. out of phase with that transmitted through the two other tubes. When the signals of both paths are equal in level at the transmitter, they cancel and net coupling between receiver and transmitter is zero. The potentiometer adjusts the level of the signal through the longer (and higher-amplification) path for exact cancellation.

NEW LITERATURE

• **American Standards Association,** 70 E. 45th St., New York 17, N. Y. announces publication of The American Standard Test Code for Apparatus Noise Measurement, Z24.7–1950, a guide for those who use sound-level meters that meet ASA standards. The standard includes procedures for factory tests of equipment, field investigations, and sound-level specifications. It was developed by a committee representing various industries, under the sponsorship of the Acoustical Society of America. Copy may be obtained upon remittance of fifty cents to the publisher.

• **S.S. White Industrial Division** of S.S. White Dental Manufacturing Co., 10 E 40th St., New York 16, N. Y. has recently issued a 12-page booklet outlining the principles of flexible shaft selection and application. Of unusual interest is a section titled "Flexible Shaft Do's and Don'ts". Copy will be mailed free on request to the publisher.

• **Kepco Laboratories, Inc.,** 149-14 41st Ave., Flushing, N. Y. will mail free new literature illustrating and describing the Kepco line of voltage-regulated power supplies. Models shown cover a wide range of research and development requirements.

• **Allied Electric Products, Inc.,** 76 Coit St., Irvington 11, N. J. is now circulating Catalog No. 161, a 24-page three-color showing of Allied and Sheldon electrical and electronic parts and supplies. Among the new products introduced for the first time are Sheldon Type R-40 flood, spot and clear lamps, all of which are claimed to have nearly double the light output of conventional aluminized reflector lamps, yet carry the same 1000-hour average rated life.

• **Lefax Publishers,** Philadelphia, Penn., is listing over 2000 titles of Lefax pocket-size technical books in its revised 1951 catalog. Subjects covered include such diverse items as Hydraulics, Lumber Data, General math, Television and FM, Automotive Engineering etc. Catalog will be mailed free on request.

• **Fairchild Camera and Instrument Corp.,** 88-06 Van Wyck Blvd., Jamaica 1, N. Y. has available in booklet form a transcript of an address by W. J. Schubert covering use and operation of the Fairchild adaptation of the Polaroid-Land camera for oscilloscope recording. Of exceptional interest to anyone whose work calls for permanent recording of oscilloscope data, this illustrated booklet may be obtained without obligation by writing the author at the address shown above.

• **Broadcast Equipment Section, RCA** Engineering Products Department, Camden 2, N. J. has available without charge Form 2-J6934, a descriptive brochure covering the new RCA Type RT-11A high-fidelity tape recorder. Companion leaflets, also available free of cost, are Form 2-J6936, describing the new Type BK-4A ribbon-pressure microphone, Form 2-J6834-Re which covers a new wall housing for the Type LC-1A speaker, and Form 2-J6935 which contains information on a new light-weight pickup and tone arm for use with the RCA Type 70-D turntable.

• **Tube Substitution Manual.** Sylvania Electric Products, Inc., Emporium, Penna. is offering a new 40-page tube substitution manual free upon request. This booklet lists substitute types of radio and television tubes, and is arranged in nine sections with informative text and charts on general tube classifications, listings of substitutions which require circuit modifications, and various change-over diagrams. Address your request to the Advertising Department at Emporium, Pennsylvania.

Photo shows magnetic tape recorder made by A/S Proton. It requires ordinary broadcast receiving set for playback purposes, sells for 1,800 Norwegian kroner (approximately equivalent of $252.00) not including radio set; tape speed 7½ in./sec.

Magnetic Tape Used in Sound Letters

SVEND ANKER-RASMUSSEN*

Popularly known as sound-letters, a new conception of communication technique has been launched by the welfare council of the Norwegian whaling fleet, Hvalfangstens Velferdsrad. The new idea was part of a scheme devised by the council to make jobs in the whaling fleet more attractive. It called for entertainment of men who had to stay at sea or in Antarctic outposts for about six months on end, but also for facilities to form a sort of personal contact between the men and their relatives back home in Norway.

A broadcast station and a new Norwegian-built magnetic tape recorder provided the answer to the problem. The factory ship, Antarctic, was equipped with a phone transmitter and a little studio in addition to her normal wireless equipment. A further addition was a magnetophone constructed by the Oslo firm, A/S Proton, using paper-tape coated with iron dust. Similar recording equipment was installed in the music shop of Borghild Lind, Tonsberg, the home port of m/v Antarctic.

Gramophone records and local talent might have been sufficient sources of program for the broadcast transmitter of the Antarctic if the task had been only that of providing entertainment for the men. The tape recorder was there for a special reason, the idea being to exchange "spoken letters" and personal messages between the men and their families back home. Tried out during the past whaling season, the new system became a smash hit. It had only one fault: that airmail charges for the reels of recordings were a good deal higher than initially calculated. This will be remedied when the fleet goes out from Norway in December to start the next season. Instead of conventional reels, small paper-core 5-minute reels will be used to get the weight down.

During the past season 32 reels of sound-letters were sent down to the Antarctic whaling-grounds from Norway, in reply to 48 reels in the opposite direction. Other tapes from home contained excerpts from programs of the national network of Norway, Norsk Rikskringkasting, and a few transcriptions of "music-hall" and variety entertainments staged in popular restaurants and theaters at home. Mr. Erling Andersen, representative of the welfare council, directed operations at the Antarctic end and tape recordings made aboard the ship were used to combine the world news picked up by the radio officer. Radio programs from powerful international broadcast (short-wave) stations at times where men were at work were recorded for playback in off-duty hours.

Greetings from men were either recorded in the studio of m/v Antarctic or recorded there by radio from other vessels of the whaling fleet. Sound-letters from home were radiated on various wavelengths to be picked up by smaller vessels, whose crews included the men to whom the messages were intended. The recorder on the Antarctic was also used by the wireless operators for reception of very fast international code messages which could easily be decoded and copied by slow-motion playback of the tape.

A comprehensive report by Mr. Andersen to the welfare council has convinced owners of Norwegian whaling tonnage that magnetophones are necessary in the future. The experiments will be commenced on an expanded scale next season, and they will be done on sound business lines, for the ban on commercials in Norwegian broadcasting does not apply in Antarctic waters. The coming season's programs will be interspersed with half-minute plugs for commodities on which the men can spend their saved-up wages when they return to their homeland.

* *c/o Universal Trade Press Syndicate, 724 Fifth Ave., New York 19, N. Y.*

TERMINAL IMPEDANCE

[*from page 22*]

the tube characteristics. This condition is sometimes corrected by placing a resistor in parallel with the load. It can be corrected equally well by using an attenuation pad between the amplifier and the load. Let it be required to find the amount of reduction of impedance variation that can be effected by means of a 3 db pad between an amplifier and a speaker load. The impedance of the speaker used rises from a nominal value of 8 ohms at 400 cps to 20 ohms with a phase angle of 45 deg. at the high-frequency end of its range. If an 8-ohm pad is used, the terminating impedance ratio is $1.77 + j1.77$. From the chart this corresponds to a value of W equal to $0.59\angle 33°$. Dividing the magnitude by 2, the power ratio of the pad, W' equals $0.295\angle 33°$. From the chart the terminal impedance ratio is $1.5 + j0.55$, and the terminal impedance is $12.8\angle 20°$. This impedance more closely matches that of the amplifier, and the reactive component of the load is greatly reduced.

It is of interest to note that the diagram may be used to compute the input impedance of a wave filter if the attenuation and phase constants of the filter are known. For this calculation an additional operation is performed in step 3. The angle of the phase constant is doubled and subtracted from the angle of W when the value of W' is obtained.

Appendix

The expression relating the terminal impedance, terminating impedance, and attenuator constants is:

$$e^{2\theta} = \frac{Z_{K2}/Z_L - 1}{Z_{K2}/Z_L + 1} \times \frac{Z_{K1}/Z_1 + 1}{Z_{K1}/Z_1 - 1} \qquad (1)$$

Let us define a quantity, W, according to the following identity;

$$W = \frac{P_1 - 1}{P_1 + 1}\ ;\ W' = \frac{P_L - 1}{P_L + 1} \qquad (2)$$

Upon substituting (2) in equation (1), and using appropriate subscripts, we obtain:

$$\frac{W}{e^{2\theta}} = W' \qquad (3)$$

In the above equations, the quantities are defined as follows:

$P_1 = Z_1/Z_{K1}$ or Z_{K1}/Z_1
$P_L = Z_L/Z_{K2}$ or Z_{K2}/Z_L
Z_1 = terminal impedance
Z_L = terminating impedance
Z_{K1} = image impedance of the attenuator on the terminal impedance side
Z_{K2} = image impedance of the attenuator on the terminated side
$e^{2\theta}$ = antilog *db/10*, the power ratio of the attenuator

An examination of equation (3) shows each side to be of the same form, but with the left side divided by the power ratio of the attenuator. If then a graphical representation is made of W, the complex transformation of equations (2) and (4), the resulting chart may be used to solve for the impedance ratios P_i and P_L.

The representation of W on the complex P plane is, for this application, best accomplished by two families of orthogonal circles, one of constant magnitude and the other of constant phase. The equation of the circles is obtained by substituting for P in equation (2) the complex equivalent $X + iY$. With this substitution equation (2) becomes:

$$W = \frac{(X-1)+iY}{(X+1)+iY} \qquad (4)$$

$$W^2 = \frac{(X-1)^2+Y^2}{(X+1)^2+Y^2} \qquad (5)$$

Equation (5) may be arranged in the following form:

$$\left[X - \frac{1+W^2}{1-W^2}\right]^2 + Y^2 = \frac{4W^2}{(1-W^2)^2} \qquad (6)$$

This is the equation of the constant magnitude circles. The circles are centered on the real axis with a displacement from the imaginary axis by a distance equal to $(1+W^2)/(1-W^2)$. The radius is equal to $2W/(1-W^2)$.

By rationalizing the denominator of equation (4) we obtain:

$$Tan\,\theta = \frac{2Y}{(X^2+Y^2-1)} \qquad (7)$$

This, when rearranged as follows, gives the equation for the constant phase angle circles.

$$X^2 + (Y - Cot\,\theta)^2 = Csec^2\,\theta \qquad (8)$$

The centers of these circles are located on the imaginary axis and are displaced from the real axis by a distance equal to $Cot\,\theta$. The radius is equal to $Csec\,\theta$. The complete circle diagram is shown in *Fig.* 1.

The approximate solution results from the following consideration. If Z_K/Z_L approaches one, then Z_K/Z also approaches one, and equation (1) reduces to the expression:

$$\frac{Z_i/Z_K - 1}{e^{-i\theta}} + 1 = Z_i/Z_K \qquad (9)$$

POSITIVE FEEDBACK

[*from page 19*]

study, it was considered most satisfactory to provide a frequency response characteristic similar to that shown in *Fig.* 3, labelled INPUT-3. If the frequency range of the source of signal extends thruout the audio spectrum, this curve seems best. However, on sources having limited frequency response characteristic, the NORMAL CURVE shown in *Fig.* 4 was excellent. If these peaks are in the range of frequencies being very actively reproduced, an unnatural effect is experienced which is not normally recognized except by experienced and critical listeners. The NORMAL curve in *Fig.* 5 was a satisfactory listening curve to use as a basic characteristic. The chief advantage of the one shown in *Fig.* 3 seemed to be in the bass end. While "stage-property moving" and the blast of air in pronouncing p's was more noticeable, the overall result was more realistic and pleasing. Measuring the amount of positive and negative is difficult since there are two positive feedback loops. However, voltage readings for negative feedback before and after disconnecting were taken and are shown in Table I. The voltages were read on a vacuum tube voltmeter.

TABLE I

Frequency—cps	Voice Coil Volts connected	Voice Coil Volts disconnected
18	0.4	0.1
30	0.4	0.6
100	0.4	1.6
500	0.4	1.6
1000	0.4	1.4
5000	0.4	1.3
10000	0.4	0.9
20000	0.4	0.1

By moving the arm on the potentiometer R_4 to the ground end, the decrease in voice-coil voltage at 500 cps was from 1.0 to 0.47 volts. This does not entirely disconnect the low-frequency positive feedback loop and there is still positive feedback. Since the high-frequency loop is most effective at a very high audio frequency, the positive feedback at that frequency is accordingly higher. From these measurements and circuit considerations, it is estimated that the negative feedback at 500 cps is of the order of 30 db, with the positive feedback being of the order of 20 db. In other words, positive feedback employed in this way allows 30 db of negative feedback and permits only 10 db loss in the overall amplifier gain. Reduction in generator impedance is equivalent to 30 db of negative feedback. This changes at the ends of the audio spectrum. It is actually possible to obtain *negative* generator impedance. This is exemplified by the case where the feedback was adjusted on this amplifier in such a way as to produce a dip in the frequency response characteristic where the fundamental resonance of the speaker would normally produce a peak. The best feedback adjustment provides a smooth curve through this region. This indicates that practically zero generator impedance exists. A further illustration of this is shown in a test where the frequency-response curve was taken by measuring voltage across the voice coil of the speaker and then re-running the test after substituting an equivalent resistance of 8 ohms. These data are given in Table II.

TABLE 2

Frequency	Volts at voice coil	Volts at register
20	2.62	2.68
30	1.79	1.82
50	1.41	1.39
100	1.10	1.10
200	1.02	1.02
500	1.00	1.00
1000	.98	.98
1500	1.02	1.02
2000	1.04	1.04
3000	1.05	1.05
5000	1.16	1.12
7000	1.27	1.13
10000	1.53	1.38
15000	2.28	2.28
20000	3.73	4.71

A further indication is that no variations in volume level are heard as the oscillator input is swept thru the audio spectrum. Voltage observed at the voice coil varies exactly as shown in the curves of *Fig.* 3, 5, and 9—that is, smoothly and without peaks or dips.

Using a Hewlett-Packard audio oscillator, a Dumont 208B oscillograph, a Dumont electronic switch as a square-wave generator, and other miscellaneous equipment found in an industrial electronics laboratory, several distortion indicating tests were made. A Clarkstan 104–1, 60–10,000 cps sweep-frequency record, a Columbia 10003M test record, and a Columbia LP RD103 test record were also used. These tests were augmented by a large number of critical listening tests involving musicians, radio engineers and consultants, and audio enthusiasts.

Square waves from 50 to 500 cps were reproduced faithfully with sharp corners and no tendency to "ring" at either end of the square wave. The sweep-frequency characteristic obtained from the Clarkstan record reproduced the curve in *Fig.* 3 accurately except that the high-frequency end was down slightly. The marker pips were sharp and distinct. The high-frequency loss increased towards the center of the record and was presumed to be the record characteristic. Frequency-response reproduction of the Columbia 10003M and RD-103 records are shown in *Figs.* 6 and 7.

A-B tests were run in competition with a well known custom-built all-triode amplifier, considered by many to be the best that can be bought. Both amplifiers drove a Bozak B-201 speaker. Both were driven by a Presto turntable using a Pickering pickup on LP demonstration transcription. The positive-feedback amplifier seemed to be cleaner on the high-frequency end of the audio spectrum. More damping of the extreme lows also seemed evident, although there was some variation in the opinion among the listeners on this point. No A-B tests were run on live-music FM broadcasts, which, through this amplifier, are the most life-like of any electronically reproduced music to which the author has listened. Remarkable "presence" is felt.

(To be concluded in the March issue)

ERRATA

A. E. Richmond, author of the article "Rapid Attenuator Calculations Using the Vector Slide Rule" in the December 1950 issue, reports the following errors on page 46:

The formula at the middle of the column should have the fraction bar inserted, to read $\theta = \cosh^{-1}\sqrt{Z_1/Z_2}$.

Step 4 of the calculation procedure should read "To determine this minimum loss in decibels, *multiply* θ by 8.686. Use Scales C and D."

Industry Notes--

Altec Lansing Corporation has opened a new plant in Beverly Hills, California, to supplement the production facilities in Los Angeles and New York, and consolidated the two Hollywood offices with the new 30,000-sp. ft. plant at 9356 Santa Monica Blvd. New plant will assemble and test loudspeakers and amplifiers, and will build miniature condenser microphone, recently given annual Electrical Manufacturing award for outstanding achievement in design and development of an electrical product.

Crest Transformer Corporation, Chicago, adds G. G. Willison Co., 2030 Harold St., Houston 6, Texas, to rapidly increasing sales staff as representatives for Louisiana and Texas.

Electronic Measurements Corporation, formerly of 423 Broome St., New York, announces removal of their offices and factory to 280 Lafayette St., New York 12, N. Y. New quarters afford twice the floor area for manufacturing facilities, and permit meeting the demand for company's electrical test equipment.

General Cement Mfg. Co., Taylor and Russell Aves., Rockford, Ill. announces opening of second modern plant at 10th Ave. and 10th St. in Rockford. New 30,000-sq. ft. unit will manufacture TV accessories such as antenna mounts, stand-off insulators, and indoor and outdoor antennas.

Industry People--

Karl Bretz promoted from Assistant Sales Manager of Electrical Reactance Corporation to Sales Manager. . . . **William H. Hazlett** appointed Field Representative in the Eastern Seaboard, for Audio & Video Products Corp. of New York. . . . **Captain David R. Hull, USN (Ret)** elected a Vice President of Raytheon Manufacturing Company, Waltham, Mass. . . .

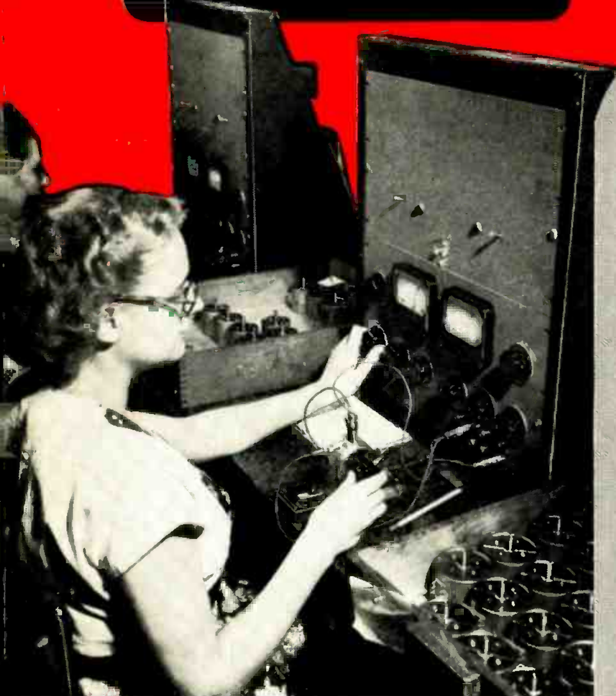
Julius Haber appointed Director of Advertising and Sales Promotion for RCA Technical Products. Will be attached to staff of Vice President in charge of Technical Products. John P. Taylor continues as Manager of Advertising and Promotion for Engineering Products Department. . . . **Gilbert C. Knoblock** appointed General Sales Manager of Standard Transformer Corporation, moving up from Advertising and Sales Promotion Manager. . . . **James McA. Krampf** named Assistant Sales Manager, Electrical Reactance Corporation, Olean, New York. . . .

Frank Marshall, formerly Sales Manager of Aerovox Corporation, New Bedford, Mass. promoted to newly created position of Director of Sales for Aerovox and subsidiaries. . . . **L. D. Netter, Jr.** appointed General Sales Manager of Altec Service Corporation; will also handle Product Sales made by the Service Company in its role of MfgRep for Altec Lansing Corp. . . .

E. A. "Mike" Quick appointed Sales Manager of Aerovox Corporation, New Bedford, Mass. Charles Golenpaul continues as manager of jobber sales. . . . **A. E. Sinclair** appointed Industrial Relations Director of Federal Telephone and Radio Corporation, Clifton, N. J. . . . **Ray F. Sparrow** named Senior Vice President of P. R. Mallory & Co., Inc., Indianapolis, Ind. Joined Yaxley Mfg. Co. in 1923, and consolidated it with Mallory in 1931, serving as Vice President in charge of sales since that time.

ADVERTISING INDEX

You Can Depend on DAVEN for *Accuracy* in Attenuators



*F*or many years Daven has beeen known for the quality of its attenuators. And, although Daven production has grown to include a wide variety of instruments for the electronics industry, the development of its attenuators has grown apace. Much of the testing equipment used by Daven to guide them in the manufacturing of attenuators has been developed by Daven's own engineering specialists. As a result, Daven attenuators have become the standard of the industry, by which all other similar equipment is measured. Shown and described here are two of the newest units that are typical of the vast Daven line of attenuators. Your inquiry for specific information to apply to your own particular problems is invited. Let Daven furnish you with completely detailed catalog data.

THE DAVEN CO.
185 CENTRAL AVENUE
NEWARK 4, N. J.

RF Attenuation Network

This equipment is an exclusive Daven development. It is a moderately priced attenuator incorporated in an RF Attenuation Box to insert accurate losses from D.C. to 225 MC. The unit has many applications where attenuation of UHF is desired, since it can be utilized as an all-purpose laboratory and test instrument.

SPECIFICATIONS:

ZERO INSERTION LOSS OVER ENTIRE FREQUENCY RANGE.
FREQUENCY RANGE: Zero to 225 MC.
IMPEDANCE ACCURACY: Within ±5% over frequency range.
ATTENUATION ACCURACY: ±5% over frequency range.
CONNECTORS: Receptacles are supplied. Cable plugs, if required, will be supplied at a slight additional cost. When ordering, specify which type connector is desired—either Series "BNC" (UG-185/U) or Series "N" (UG-58/U).
CIRCUIT: Constant input and output impedance (unbalanced). Zero initial loss.
RESISTOR ACCURACY: ±2% at D.C.

Carrier Frequency Decade Attenuator

This equipment is particularly applicable to extremel accurate measurements from D.C. to 200 kc. and can be used up to the lower radio frequencies. The Decade type switches make the box convenient to use. In addition, there are switch stops which prevent return from full to zero attenuation when making adjustments. A total of 110 Db. is available in 1.0 Db. steps, or 111 Db. is available in 0.1 Db. steps. Both of these types may be obtained in either a balanced H or an unbalanced T network.

SPECIFICATIONS:

ACCURACY: Each individual resistor is adjusted within ±0.25% of its correct value. The error in attenuation is less than ±1% of the indicated value, provided the output is matched by a pure resistance.
FREQUENCY ERROR: At frequencies below 200 kc., the total error in attenuation will not be greater than ±1% of the indicated value.

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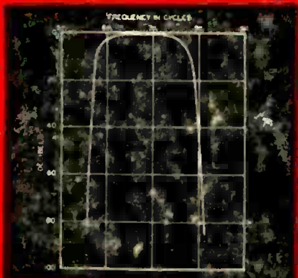

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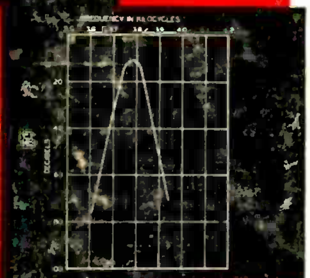

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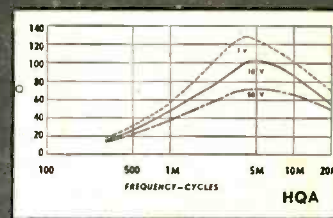

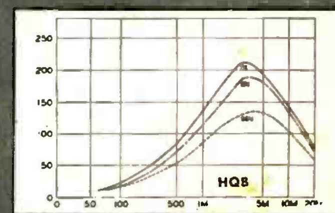

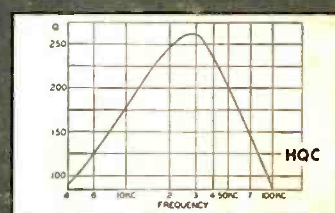

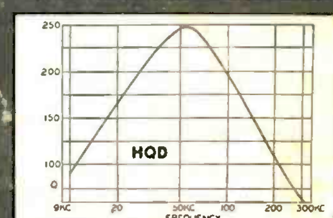

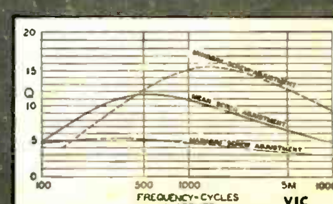

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