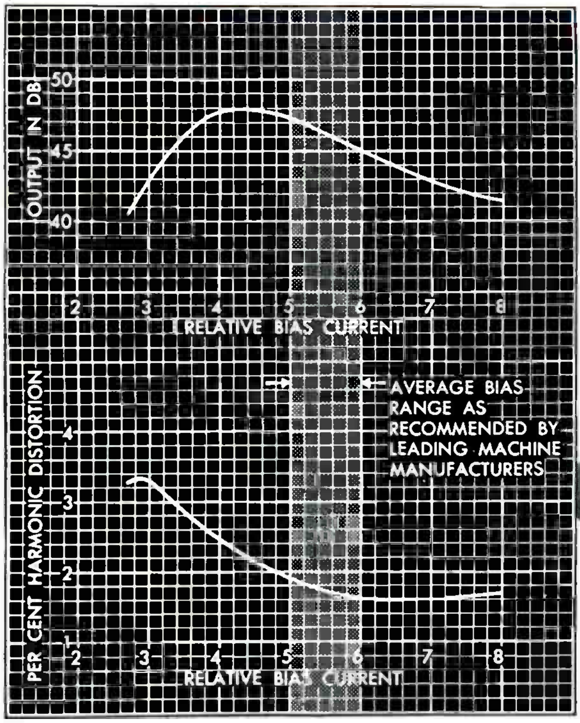
AUDIO ENGINEERING

JUNE
1951
35c

Published by RADIO MAGAZINES, INC.

For MAXIMUM OUTPUT with MINIMUM DISTORTION



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CONTENTS JUNE, 1951 Vol. 35, No. 6

AUDIO engineering society SECTION

COVER

A view of a few of the overhanging boxes and part of an audience assembled for an acoustic test concert given by the London Symphony Orchestra under the baton of Basil Cameron in the recently completed Royal Festival Concert Hall, London. This hall is being used during the Festival of Britain which runs until September, and holds an audience of over 3000. The acoustic treatment on the front of the boxes, of "ship's bridge" design, is readily discernable. The photo was supplied by British Information Services.

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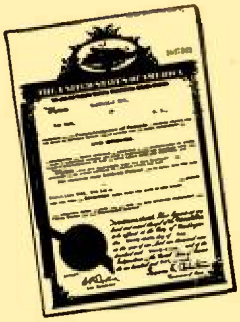


AUDIO PATENTS

RICHARD H. DORF*

It is an old adage we all learn in our early school years that two things cannot occupy the same space at the same time. Nothing in our own experience has ever really refuted that statement, but Patent No. 2,536,664 looks at first glance as though it might. In it, Chester M. Sinnett and Herbert Belar (who have assigned the patent to RCA) show how to put two completely different musical selections in the same grooves of one side of a record.

The patent is entitled "Stereophonic Sound System for Recording," so that is how we shall describe it initially. The setup is shown in block form in *Fig.* 1, with a

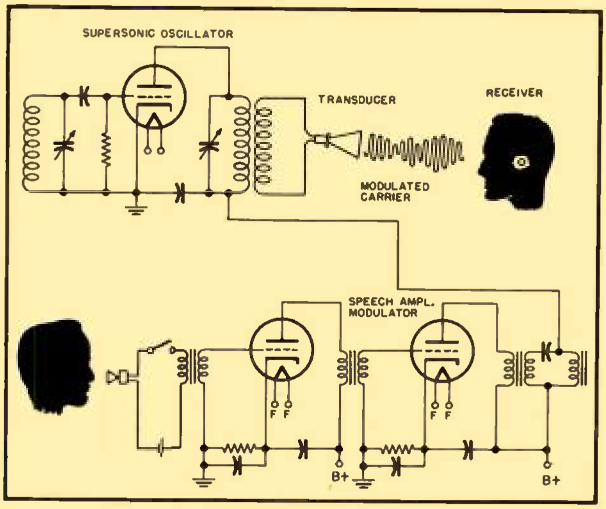
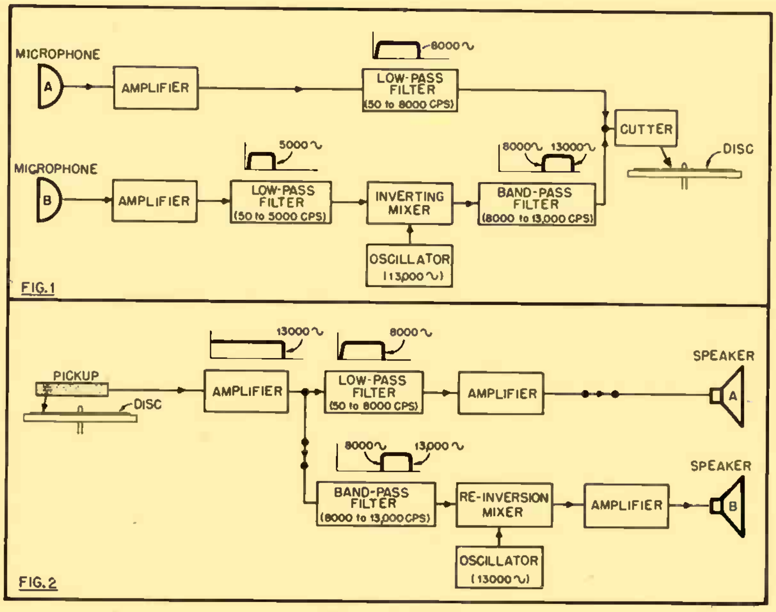


Figure 3



Figures 1 and 2

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* *Audio Consultant, 255 West 84th Street, New York*

pair of microphones, *A* and *B*, placed in the usual positions for binaural pickup. The output of microphone *A* goes through an amplifier and to the cutter in the usual way, except that it is filtered so that transmission is sharply cut off at and above 8,000 cps.

The signal from microphone *B* is amplified and filtered so that only frequencies between 50 and 5,000 cps remain. Then the signal is inverted in frequency by the (theoretically) simple method of beating it with a fixed-frequency 13,000-cps oscillator. From the beating process a range of difference frequencies is produced—from 13,000 minus 50, or 12,950 cps to 13,000 minus 5,000, or 8,000 cps. The sum frequencies are filtered out by the 8,000-13,000-cps bandpass filter which follows the inverter. The 8,000-13,000-cps band is fed to the cutter along with the 50–8,000-cps band produced by microphone *A* and a record is cut in the usual way containing a continuous band from 50 to 13,000 (or, to be exact, 12,950) cps.

Figure 2 shows how the record is played back so that the two microphone signals can be separated. The first amplifier brings up the level of the whole 50–13,000-cps range on the record. A low-pass filter cutting off at 8,000 cps passes the band originally recorded from microphone *A* through its own amplifier and to speaker *A*. A bandpass filter operating from 8,000 to 13,000 cps selects the inverted microphone-*B* signal and feeds it to an inverting mixer exactly like that in *Fig.* 1. The re-inverting process recovers the 50–5,000-cps original signals from microphone *B* and feeds them to speaker *B*—whereupon we have two-channel, binaural, stereoscopic reproduction.

To clarify my first paragraph—although we have two separate sound channels where only one existed before on the record, we still haven't crammed two things into the same space or eaten our cake and had it too. Note that the bandwidth of each channel is much smaller than that of one full-fidelity channel, which is what the two together add up to. Still, the binaural effect might be well worth the lack of highs to many people.

Perhaps a more interesting possibility is one not particularly involving fidelity. That is the idea of saving record space and cost by putting two completely separate recordings on the same disc for file or reference purposes. Actually, you could have three or perhaps even four if you were willing to have a narrow enough band for each, say 50–3,000 cps or just enough for speech intelligibility. Then the first channel would occupy 50–3,000 cps. The second would take 4,000–7,000 (with a 1,000-cps guard band between 3,000 and 4,000); the third would occupy the 8,000 to 11,000-cps band. The two oscillators would operate at 7,000 and 11,000 cps respectively.

There is no room here for circuitry but the patent drawings contain some, and the patent text contains some more interesting ideas. Like all others, it is available for 25 cents, postpaid, from the Commissioner of Patents, Washington 25, D. C.

Supersonic Communication

Carter Tiffany is the inventor of an intriguing idea for electro-acoustic communication with the use of ultrasonic frequencies. He argues that it would be very handy for directors to talk to television actors during the show or in many other situations where instructions must be given on the q.t.

Tiffany's patent (No. 2,542,594) proposes the equivalent of an amplitude-modulated transmitter with a supersonic carrier. The carrier, amplitude-modulated by the voice

[*Continued on page 38*]

Hollywood Letter

C. A. HISSERICH*

In the February Letter several comments were made regarding "print thru," especially the seriousness of the problem involving the thin-base recording materials. Several communications were received regarding these comments, and it seems to be the consensus of opinion that the print thru is now being minimized by reducing the maximum modulation level on these materials until it is no longer objectionable.

This technique of reducing the maximum modulation level opens up a field which, while not new, seems to have never been completely answered commercially; and certainly many comments made in this article will be subject to controversy. In fact, the controversy regarding the most "graceful" or "pleasing to listen to" method of limiting, clipping, compressing, etc., of recorded material is still as much in contention as it was twenty years ago.

Some twenty years ago, when the first light-valve modulators were used for optical recording, they were subject to serious damage when excited with high signal levels. The commonly used method of protection was to drive these modulators with a triode amplifier followed by a T pad of such value that the amplifier "laid down" at a signal level corresponding to a few db over 100 per cent modulation. This system prevented damage to the modulators from gunshots and similar high-level input signals, and the distortion generated in the amplifier working close to overload was not objectionable. However, with improvements in modulator materials, modulators were developed which were not damaged by overloads of several hundred per cent. Attempts were made at that time to let the amplifiers drive the modulators to 100 per cent modulation with low amplifier distortion. The results were not as expected; the effect of running a "clean" system into a modulator which suddenly generated its own distortion at the fixed level corresponding to 100 per cent modulation was much more disagreeable to listen to than the previously used gradual overload.

This statement will probably bring up the question of the whereabouts of the mixer, or the validity of the volume indicator, or the reasons for exceeding 100 per cent modulation. Suffice to say that with the average mixer, using a high speed VI and attempting to hold a maximum modulation level, there will be peak amplitudes of signal from normal material which will consistently exceed 100 per cent modulation by 8 db. This is not to be construed as an indictment of mixing ability, but rather as a statement of the lack of available equipment which adequately indicates peak input amplitudes. The figure of 8 db was obtained by monitoring several production channels with a 'scope during a normal day's shooting.

The figure of 8 db increases to 12 db or more when vocal choruses or other complex waveforms are encountered. It is true that there are a few peak-reading volume indicators available, but they are not in general use, largely because of the time constant incorporated in the needle return.

With the advent of the push-pull modulator for optical recording, the effect of modulator overload was much less noticeable with high-margin driving systems, and this type of modulator came into general use for original optical recordings. It is quite illuminating to listen to high-level passages on push-pull and then to play the same material back single-ended; only then can the beneficial effects of symmetrical overload or push-pull harmonic cancellation be fully appreciated.

Several attempts have been made in the motion picture industry to use electronic compressors, but the reaction has been largely negative. Static distortion tests on such devices have absolutely no meaning because the distortion is generated during the time of the gain change; in fact, *one point not commonly appreciated is that changing the gain of a system manually with a mixer potentiometer will introduce sidebands which are the resultant of modulating the frequencies present in the system by the frequency of the gain change.* The effect of continuously changing the gain automatically accounts for some of the weird effects obtained with compressors.

Comparison to Tape

Thus it will be seen that levels have been maintained by accepting a reasonable degree of peak overload, and by attempting to minimize the disagreeable effects of this overload by utilizing the beneficial effects of push-pull harmonic cancellation. With the advent of magnetic recording, this type of operation has continued. It is not generally recognized, but magnetic recording is inherently push-pull because of the bi-directional magnetization characteristics of the tape material. In optical recording (of the density type), the modulation operates from a neutral density (gray) towards the opaque (black) in one direction, and towards the clear (white) in the other direction. Unfortunately, the neutral density (gray) contains finite silver grains which create noise. In magnetic recording, in contrast to this condition, no magnetization exists on the individual magnetic particles under conditions of no modulation, hence they are not contributing to the noise. With modulation, a true symmetrical condition of magnetization exists about this zero magnetization condition because in one direction the magnetization is *N-S* and in the opposite direction the magnetization is *S-N*. The only approach to such a system in the field of optical recording is the push-pull Class B type of recording, a system not in general use. The point to be made here is that any single-ended density recording operates in one direction towards the toe of the H & D curve of the film and in the other direction towards the knee of the H & D curve, and hence is not inherently symmetrical; magnetic recording, on the other hand, is symmetrical because operation is over the same magnetic excursion in both directions, only the sign of the poles being reversed.

From the above conditions, it has been found that a "graceful" overload characteristic can be obtained with magnetic recording techniques, similar to those obtained with push-pull optical modulators. It is necessary, however, to modulate the tape close to saturation to accomplish this effect, hence the concern about "print thru."

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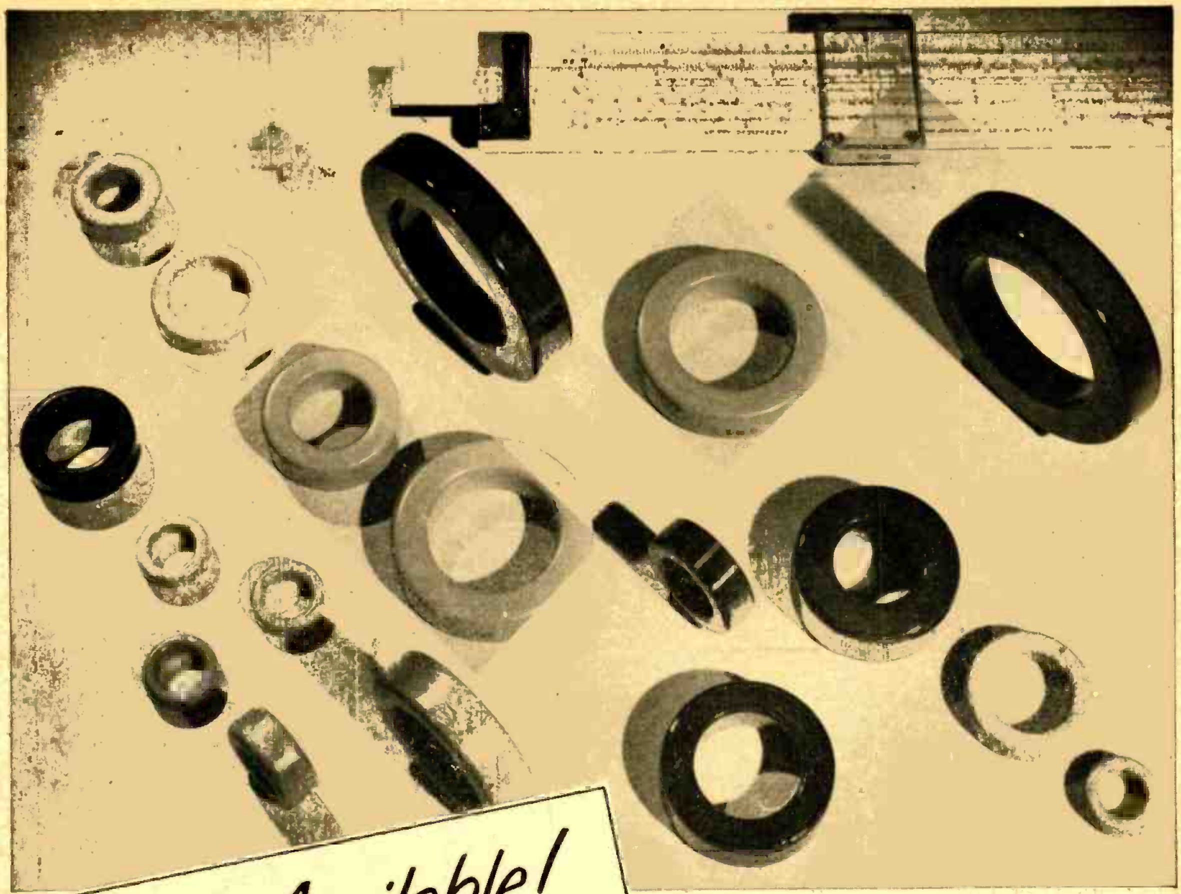
* *954 Hancock Ave., Los Angeles 46, Calif.*



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W&D 2930

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LETTERS

Electronic Music

Sir:

We have been very pleasantly surprised that you have continued to give us patent excerpts, especially the one in your August issue.

On page 38 you ask if any of us is interested in more data on Electronic Music. BUT VERY MUCH so. For the past seven or eight months the writer has been trying to get more information on this subject. Some months ago a paper was given on a multi-element tube for the use in electronic music circuits. At that time I tried to induce some one to give us more on the same subject, but so far I have had no success.

Never has there been a better time than the present to introduce Electronic Music.

W. Stuedeman,
1 N. Harrison St.,
East Orange, N. J.

(*Æ agrees heartily, but so far has met with as little success as Mr. Stuedeman. Any offers?*)

Re: Pickups and Tone Arms

Sir:

In the article on a new Pickup and Tone Arm (Æ, March, 1951), the authors apparently recommend the choice of an offset angle which will make the angular tracking error zero at both minimum and maximum radii of the record, and cite a maximum error of 4 deg. for their final design. I am curious to learn why an offset angle was not chosen which would make a zero tracking error at two intermediate radii, thus causing a maximum tracking error of plus or minus 2 deg.

According to B. B. Bauer, the angular tracking error is not the best criterion for distortion, and this type of tracking distortion at any record radius is proportional to the ratio of the angular error to the radius.

It is easy to show that in terms of peak stylus velocity, V, the distortion equals $\frac{V \tan \alpha}{4 \pi S r}$, where S is the groove speed.

Applying the above to the authors' tone arm design for the case of the outer groove of a 45-r.p.m. record with an assumed modulation peak velocity of 5.5 in./sec. it is found that the distortion is 1.2 per cent. This distortion is not very large, but with the combination of the optimum offset angle and distance from the record center to the vertical axis of the arm, the maximum distortion can be reduced to a value of only 0.42 per cent.

J. H. Pressley,
1036 San Diego Rd.,
Santa Barbara, California

Voltage Amplifier Circuit

Sir:

The May Patent column described a voltage regulator circuit developed by Daniels, who is currently my associate, and I have used his circuit on several occasions.

The gain that can be achieved is considerably greater than the "high hundreds." Using a 6SH7 and a 6SF5, a gain of 6000 is readily obtained.

Among other advantages, the circuit is well adapted to use in negative feedback circuits because of its favorable phase-shift characteristics.

John W. Hogan,
617 East 24th St.,
Minneapolis, Minn.


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EDITOR'S REPORT

LOUDNESS vs. FREQUENCY CONTENT

LISTENERS occasionally mention the variation in level during different parts of a radio program, with the complaint that voice and music are reproduced in a relation which is not in accordance with what might be expected, considering the difference in power of the two sources.

Aside from the interest of a sponsor in making sure that his message is heard, there are several other explanations for this effect, one of which may well be that the level of a broadcast program is usually adjusted to provide a uniform indication on the VU meter, rather than for a balanced sound output as heard by the engineer. During the musical portion of the program, the VU meter is indicating the total volume in the signal, and it is well known that there is likely to be considerable power in the low frequencies which is not so obvious in sound output from the average loudspeaker. Therefore, the narrower the reproduced band of frequencies, the more the discrepancy between levels for different types of program material, because the VU meter is affected by the entire range of frequencies, while the ear does not hear all equally as acoustic output from the speaker.

The listener with wide-range speaker facilities—equivalent to better-quality monitor speakers in the station—is likely to notice a lesser differential than the listener with a table model set using a five-inch speaker.

If the monitoring were done principally by listening to the monitor speaker rather than by adjusting the level to satisfy the VU meter, it seems that this trouble would not exist at all if the speaker were sufficiently good—which brings the discussion back to an oft-expressed need for monitoring facilities of the highest possible quality in radio and recording studios.

AUDIO PATENTS

It has often been said that some people believe anything they see in print, and Æ is always edited in accord with that premise just in case someone in that category happens to pick up a copy.

With respect to the review of patents in the audio field, however, readers are cautioned to remember that the issuance of a patent is no indication that the device will ever be marketed. Since it usually takes from two to three years after application is made until a patent is issued, and since the enterprising inventor is understandably anxious to improve his financial position by marketing his brainchild before the patent is actually granted, it must be realized that the possibilities of selling the article have usually been explored thoroughly during the time the patent application is working its way through the steps preceding the issuance of the patent. Since many products are actually marketed well before the patent is granted, it seems safe to assume that if the device were to be commercialized at all it would probably be on the market long before it is described in the patents column.

THE SOCIETY AND THE MAGAZINE

Although the relationship existing between the Audio Engineering Society and Æ is generally well understood, it is apparently not reiterated with sufficient frequency. The Society is an organization of those interested in audio engineering as a profession and as a hobby, and its income is derived from membership dues. While Æ is its official publication, no member is required to subscribe, nor do the membership dues include a subscription to the magazine. The papers of the Society are printed separately and distributed to the membership, and are punched for insertion in a binder which is provided for that purpose. Some two or three months later, these papers appear in Æ, where they may be read by everyone.

It is important to remember that the Society does not necessarily approve of all the material which appears in Æ, nor does Æ necessarily approve of all the papers which are presented in the Society's section. Æ is fortunate in being able to bring these papers to its readers, however, because of the mutuality of interest between Society members and Æ subscribers. But membership dues do not include a subscription, nor do subscribers automatically become members of the Society.

BASS REFLEX

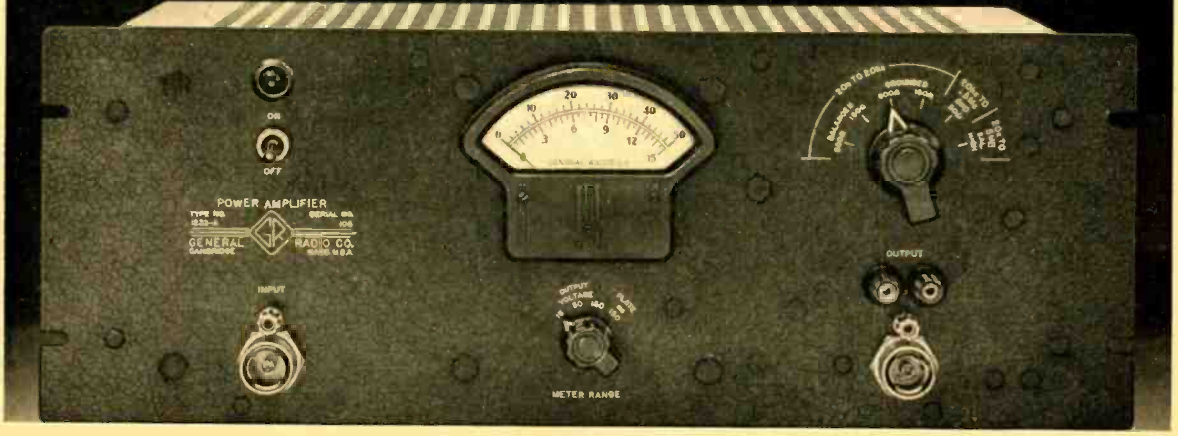
Long known as a trade mark of Jensen Manufacturing Company, the term "bass reflex"—denoting a vented loudspeaker enclosure—has been released by its owners to public domain, thus making it possible to describe such a cabinet by a phrase which heretofore rightfully referred exclusively to Jensen products.

Many words created to describe a particular product attain general use, contrary to legal rights, and often become better known than the common name of the item. Familiar examples are Kodak, Bakelite, and Deepfreeze—all of which denote the products of a certain manufacturer, although similar products are made by others. Correct usage demands that such words must be capitalized when used in text, and must be used only in reference to the specific product.

The term "bass-reflex" is so descriptive and so easily understood, however, that it naturally comes to mind to describe *any* vented cabinet. Æ is pleased to express its gratitude to Jensen for releasing it to general use.

Announcing a New Wide-Range Power Amplifier

with Substantial Output from 20 Cycles to 3 Megacycles



THE USES for a wide-range aperodic amplifier in the laboratory are many. A wide range amplifier of considerable output is particularly useful in development and general testing of audio-frequency equipment, and in driving supersonic generators.

The new G-R Type 1233-A Power Amplifier has three output combinations:

20 cycles to 20 kilocycles, into 150 or 600 ohms, balanced or grounded. Output of 15 watts is provided between 50 and 15,000 cycles.

20 kilocycles to 1.5 megacycles into 50 ohms, grounded. Output 15 watts from 30 kilocycles to 0.5 megacycles; 8 watts at 1.5 megacycles.

20 cycles to 3 megacycles; output 150 volts peak-to-peak, for a high impedance load with a gain of 60 db. With grounded output, voltage is limited to 50, peak-to-peak, with a gain of 54 db.

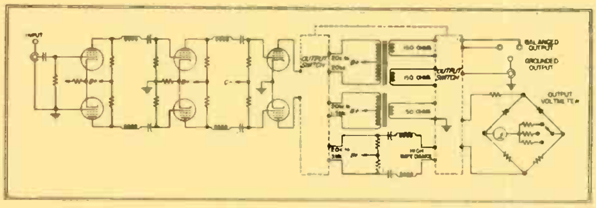
The 20 cycle to 3 Mc output is intended for use as an oscilloscope deflection amplifier. The maximum output is secured in all cases with an input voltage of 0.2 volt. Distortion is below 3% at maximum output over most of frequency range. Noise is between 60 and 70 db below 15 watts.

The instrument is provided with a diode voltmeter with full-scale ranges of 150, 50 and 15 volts to indicate the output voltage.

The high voltage power supply uses selenium rectifiers in a full-wave voltage-doubling circuit and a two-section LC filter. A bias supply, using selenium rectifiers, provides fixed voltages for the output stage.

This amplifier brings to the development and laboratory technician an instrument of considerable value in that in one instrument a source of audio and r-f amplification of very high gain and very good frequency characteristic is available at considerably less cost than that required to develop and construct an amplifier or a series of amplifiers equal to the performance of this one.

Type 1233-A Power Amplifier . . . . $525.



The basic circuit consists of three push-pull broadband amplifier stages and three output circuits, selected by a switch. Interstage couplings are the series-peaked type, designed for constant gain up to 5 Mc. The input stage operates as a phase inverter.

Separate output transformers are used for the 20 cycle to 20 kilocycle and 20 kilocycle to 1.5 megacycle ranges. Both transformers are toroidally wound. Special care was necessary in the design of these transformers to achieve satisfactory performance at the relatively high frequency at which they operate. Both the leakage reactance between the primary and secondary windings and the distributed capacitance of the primary are limiting factors in determining the high-frequency performance.

Polystyrene cups are used as the interwinding insulation to keep the capacitance of the insulation at a minimum.

GENERAL RADIO Company

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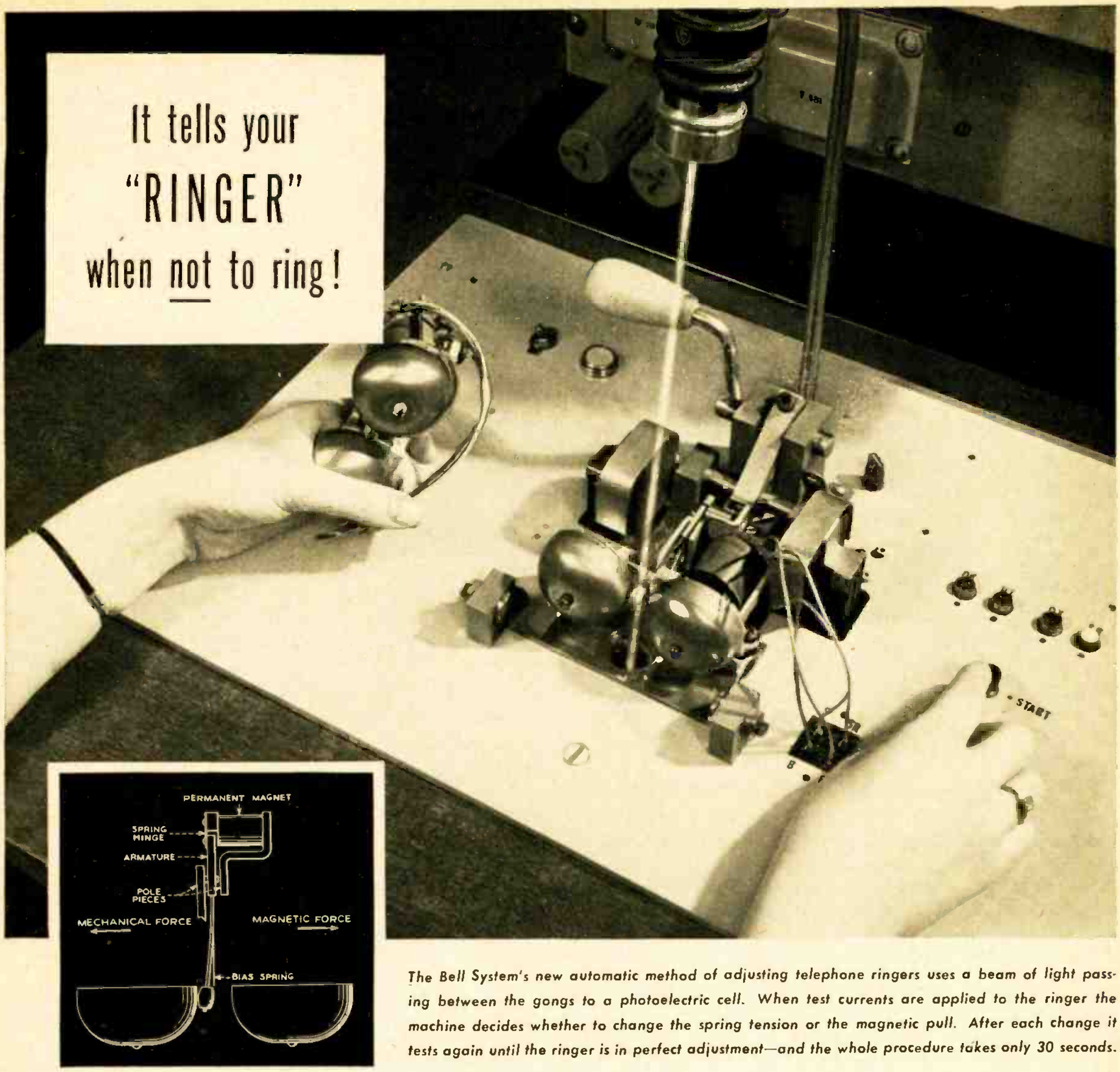
It tells your "RINGER" when <u>not</u> to ring!



The Bell System's new automatic method of adjusting telephone ringers uses a beam of light passing between the gongs to a photoelectric cell. When test currents are applied to the ringer the machine decides whether to change the spring tension or the magnetic pull. After each change it tests again until the ringer is in perfect adjustment—and the whole procedure takes only 30 seconds.

To YOU, it's your familiar telephone bell. To telephone engineers, it's a "ringer." And it has two jobs to do. It must ring, of course, when someone calls you. And it must overlook the numerous electrical impulses which do not concern it, such as those sent out by your dial.

Ability to respond to some impulses, to ignore others, requires exact adjustment between the pull of a magnet and the tension of a spring. If they are out of balance your telephone might tinkle when it oughtn't, or keep silent when it should ring.

In the past, adjustment was made by hand, little by little until the proper setting was reached. It took time. But now Bell Laboratories engineers have developed a machine which adjusts new ringers perfectly, before they leave the Western Electric Company plants where they are made. And the operation takes just 30 seconds.

This is another example of how the Laboratories work constantly to improve every phase of telephony — keeping the costs low while the quality of service grows higher and higher.

BELL TELEPHONE LABORATORIES

WORKING CONTINUALLY TO KEEP YOUR TELEPHONE SERVICE ONE OF TODAY'S GREATEST VALUES

A Brief Review of Diode Detectors

RUDOLPH L. KUEHN*

A discussion of one of the weak points in current AM radio receivers, with emphasis on the circuit parameters which affect distortion and efficiency.

THE ADVANTAGE OF THE DIODE as a detector is its ability to provide nearly linear rectification. Inasmuch as this requires a large signal voltage, the properly loaded diode is well adapted because it is not critically susceptible to overloading. Diode rectifiers used for signal detection, or demodulation, are designed for the nearest approach to linearity.

The essential principle of linear detection is that in a diode rectifier circuit with a capacitive load, the direct voltage developed across the capacitor is equal to the peak value of the input alternating voltage. There are two distinct types of linear rectifiers: one responds to the envelope of a wave form, as at (A) in *Fig.* 1, and the other responds to the average of the rectified wave pulses of one polarity, as at (B). Any linear rectifier is a compromise of the two types, but may approach one or the other type as a limit. Since the efficiency of the envelope type is nearly unity, it is preferable to the low efficiency of the averaging rectifier. Only the former will be considered here. For use in a linear rectifier of the envelope type, the ideal diode has zero impedance to current in one direction and zero admittance in the other direction. The interelectrode capacitance of the diode does not affect the linearity of detection, but does affect the carrier frequency current design.

In the operation of the simplest diode rectifier current, an ideal diode is assumed and the signal is unmodulated with an input current impedance of zero. In a circuit such as shown at (A) of *Fig.* 2, the diode current has alternating components of fundamental and harmonic frequencies which are bypassed by the load capacitor, and a rectified component, I_0 which flows through a load conductance G_0 placed across the capacitor. The rectified load voltage E_0 is free of alternating components since they are bypassed. In operation, each positive peak of the input voltage charges the capacitor to a voltage E_0 equal to the carrier peak voltage. During each negative half cycle, a small part of this charge leaks off through G_0 but is restored at the next positive peak of input voltage, resulting in a waveform as shown in *Fig.* 2. The diode current represented by this series of periodic impulses can be summed in time by a Fourier analysis:

$$I_t = I_o + \ldots + I_{nco} \cos nct + \ldots$$

where I_{nco} are the fundamental and harmonics of the alternating components. Also, $I_0 = E_{co}G_o = E_oG_o$ and $I_{co} = I_{nco} = 2I_o = 2E_{co}G_o = 2E_oG_o$. The effective carrier-frequency conductance of the diode across the input circuit is $C_{co} = I_{co}/E_{co} = 2G_o$ and the efficiency is $E_oI_o/(E_{co}I_{co}/2)$.

In the case of a modulated input voltage, however, ideal circuit operation requires that the capacitor should charge to the peak of the input wave during each carrier-frequency cycle; but that there should be sufficient current drain through G_o to cause the output voltage to decrease as rapidly as does the envelope of the input voltage. Actually, these two objectives are incompatible. Near the top of each positive peak of input voltage the diode passes a pulse of current which charges the capacitor to a voltage nearly that of the envelope, but the drop in the tube during conduction prevents the output from actually reaching peak value. When the input drops below capacitor voltage the tube ceases to conduct and the capacitor begins to discharge slowly through G_o until the next charging cycle. Hence the resulting output waveform is somewhat jagged. Essentially, though, the detector output voltage follows the envelope of the modulated input wave and has the waveform of the modulating voltage.

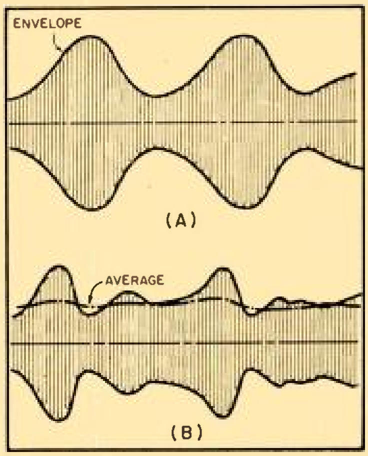


Fig. 1. Comparison between envelope type of detector (A) and average-type (B), showing output voltage obtained from each.

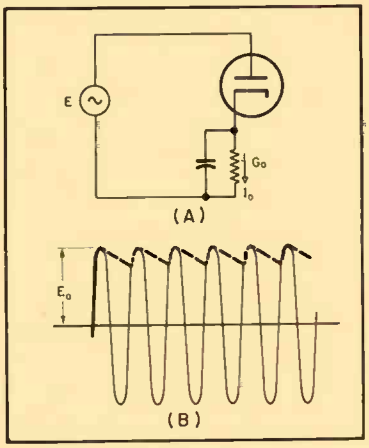


Fig. 2. (A) Simplified diode detector circuit and (B), the resultant current through load resistor when rectifying an unmodulated carrier signal.

When a practical diode detector is so operated that the efficiency is high and reasonably constant over the modulating range, the output will contain very little distortion, providing that: $(G_o/G_m) \geqq m$, where G_m = diode load conductance to modulation frequency currents, G_o = diode load conductance to direct currents, and m = degree of modulation of applied signal.

In terms of impedances, the expression $(Z_m/R_o) \equiv (G_o/G_m)$ is referred to as the a.c./d.c. impedance ratio of the diode load. When violating the above criterion —as in the case where Z_m is a resistance, but less than the d.c. resistance—then the negative peaks of the output voltage are clipped off at a point where the instantaneous amplitude corresponds to an instantaneous degree of modulation allowed by $(Z_m/R_o) \geqq m$. When such clipping occurs, the resulting r.m.s. distortion is approximately equal to the difference between the actual modulation and the allowed modulation by the above equation, divided by twice the actual modulation. When Z_m is less than the d.c. resistance, but also has a phase angle or is reactive, then the violation of the criterion above results in a diagonal clipping of the peaks. Such distortion is less than with flat clipping, but is

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certainly not negligible. The distortion is small when the criterion is satisfied, although there is some residual distortion as a result of variation of the rectification efficiency with instantaneous envelope amplitude. This is ordinarily under three per cent, tending to be smallest when the applied signal is large, the degree of modulation small, and the diode load impedance high compared with the plate resistance.

Practical Operation

Thus far an ideal diode has been assumed—that is, one which has zero resistance to current in one direction and zero conductance to current in the other direction. The nearest approach to the ideal is a high-vacuum tube having an indirectly heated cathode and operating space-charge limited. Such a diode has a current-voltage curve gradually changing from exponential for negative anode voltage to a 3/2 power curve for positive anode voltage. This exponential curve is the closest realizable continuous function that approximates the ideal diode characteristic. The equation of the exponential curve is $I_g = I_{go}\epsilon^{E_g/E_l}$ where E_g is the anode voltage and I_{go} and E_l are constants. The value I_{go} increases rapidly with temperature, whereas the value of E_l is relatively independent of operating conditions. The smallest of E_l however, determines the sharpness of curvature for small current. It will be noticed that the above equation is of the form of Richardson's well-known equation for saturation current as a function of temperature: $I_s = AT^2\epsilon^{-\omega/KT}$ in which T is the absolute temperature, ω is the electron affinity of the emitter, K is Boltzmann's constant, and A is a constant, probably universal for pure metals.

The transition between exponential and 3/2 power curves occurs at a current level which increases with greater cathode surface. The voltage drop in filamentary cathodes may be shown to change the 3/2 power law into a 5/2 power law at anode voltages (relative to the negative end of the filament) that are less than the voltage of the positive end of the filament.

If the diode characteristic is not linear, then the detected, or demodulated, wave form is not an exact replica of the applied modulation. This suggests that the output contains harmonics of the modulation voltage as expressed in the previously mentioned Fourier series. If the input wave is modulated by several frequencies, the output also contains frequencies equal to the sums and differences of the modulation frequencies and their multiples. The fundamental modulation-frequency components of the output arising from the second- and higher-order terms destroy the linearity between modulation-frequency output voltage and carrier amplitude that ensues when the characteristic is linear. The sum and difference frequencies produce dissonance particularly objectionable in musical reproduction.

In order to minimize distortion resulting from curvature of the diode characteristic, to reduce loading of the source of detector input voltage, and to attain high efficiency, the load conductance should be low. There is no advantage, however, in making the load resistor much greater than the grid coupling resistor of the following amplifier stage. Incorrect values of the capacitance in a diode detector may cause several types of distortion. The charging current that can flow into the capacitor for a given value of instantaneous impressed voltage is limited by the tube, the impedance of the source, and by leakage through the load resistor. For a capacitor which is too large, equilibrium after an increase or decrease of impressed alternating voltage amplitude may take several carrier-frequency cycles to be reached. Hence, if there is a rapid amplitude fluctuation, the changes in capacitor voltage are smaller than the changes in amplitude. Inasmuch as the change in capacitor voltage for a given change of impressed amplitude decreases as the frequency of the amplitude variation is increased, and the envelope of a modulated wave varies at modulation frequency, it follows that too large a capacitor causes frequency distortion of the detector output.

The detector load resistance not only permits the capacitor to discharge in response to the modulating voltage, but also allows it to discharge during those portions of the carrier-frequency cycle in which the instantaneous impressed voltage is less than the capacitor voltage. This causes the capacitor voltage to vary slightly at carrier frequency. The presence of carrier-frequency voltage in the output is the limiting factor in determining the minimum value of capacitance that can be used. The ratio of the amplitude of the output carrier-frequency voltage to the amplitude of the signal-frequency voltage is roughly $G_m/\mu f_c C$ where f_c is the carrier frequency. Since f_c is usually at least ten times the highest signal frequency there is no difficulty in making C large enough to reduce carrier frequency in the output and yet not so large that modulation-frequency distortion occurs. A capacitance of approximately 150 μμf is suitable for use in the broadcast band. Some reduction in size of the capacitor may be achieved from the use of a full-wave diode circuit such as is shown in *Fig.* 3. The output of this circuit does not contain the carrier frequency, hence C need only be large enough to remove the second harmonic of the carrier frequency.

Conclusion

In conclusion, the two most important characteristics of a diode detector are:

(1) The maximum degree of modulation as a function of modulation frequency that the incoming signal may have, without some form of negative clipping; and

(2) the variation of output voltage as a function of modulation frequency for an incoming signal of constant amplitude and degree of modulation. These two characteristics depend upon both the input diode impedance and the internal impedance of the source of exciting voltage, thus making it necessary to consider the diode with its load circuit and input circuit as a single system.

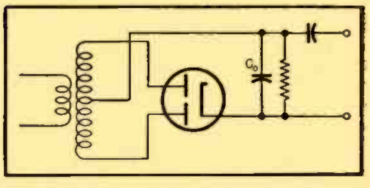

Fig. 3. Typical push-pull diode detector, with load resistor and bypass capacitor in normal configuration.

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Plan Now—Attend The Audio Fair in '51

November 1, 2 and 3—these are the dates for the 1951 Convention of the Audio Engineering Society, and the third annual Audio Fair. This year both the Convention and the Fair will be truly international in scope. Engineers from many countries are planning to attend the Convention—technical papers will cover all recent achievements in the field of Audio. The Fair will offer the greatest collection of audio equipment ever assembled in a single display. The place, as usual, will be the famous Hotel New Yorker. Admission to technical papers free to Society members—admission to the Fair free to everybody.

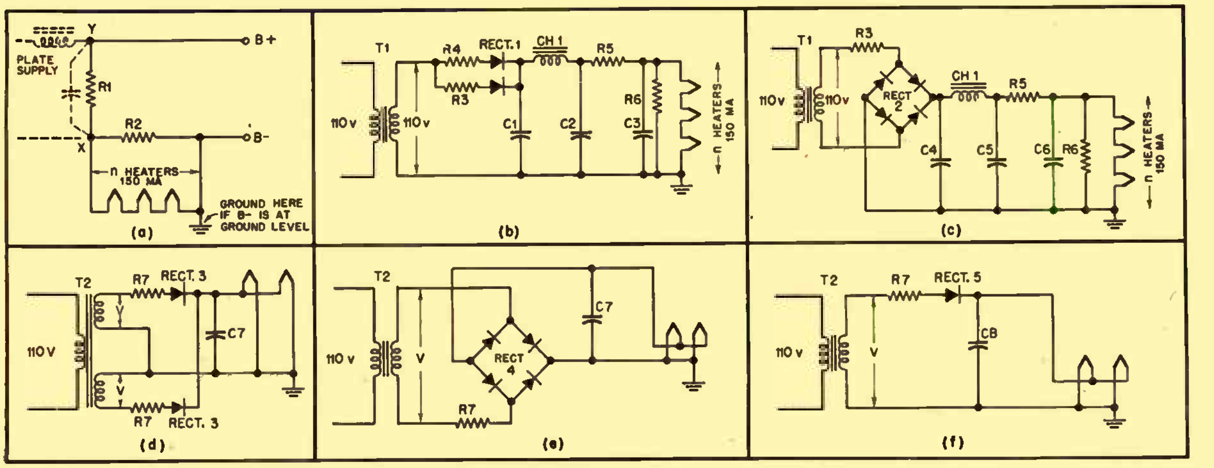

Fig. 1. Typical circuits for supply of direct current for heaters of low-level amplifier stages.

D.C. Heater Supply for Low-Level Amplifiers

L. B. HEDGE*

Hum problems in preamplifier and other low-level stages may be reduced or completely eliminated by the use of one of the d.c.-supply circuits described by the author.

THE USE OF DIRECT CURRENT to supply the heaters of pre-amplifier and other low-level, high-gain amplifier tubes is standard practice in professional and high-quality equipment design. Direct current in this application is effective in reducing hum and it has the added advantage of making critical stages less sensitive to individually selected tubes when replacement is required. This is no small advantage, as anyone who has tried to locate a quiet replacement for a defunct a.c.-heated pre-amplifier tube will appreciate. A d.c. supply for the low-level end of a good audio system is sound design practice, and it need be neither difficult nor expensive.

Basically there are two schemes for direct current heating in an alternating-current-supplied amplifier — a separate rectifier and filter may be used to supply the heaters, or they may be supplied from the regular high-voltage unit which furnishes the plate power for the amplifier. The second plan is the one most commonly used—the low-level tubes are connected in series at the low-voltage end of the plate supply circuit—but it suffers from several disadvantages:

1. It requires a heavy-duty power supply unit.
2. It reduces the available plate-voltage by the amount of the drop across the heater circuit.
3. It warms the d.c. heated cathodes with the plate voltage applied.
4. It requires a constant plate-current load.
5. In event of tube failure it may induce excessive further damage.

The heavy-duty power supply may be no disadvantage—if the plate load is in excess of 150 ma the excess will have to be bled across the heater circuit. The second and third items listed are obvious, and obviously not good. The constant-plate-load requirement may not be a serious drawback, but in some involved devices (such as magnetic recording-playback units) it may complicate switching requirements. The fifth item is often neglected—a tube which breaks down in such a way as to draw excessive plate current may easily cause a heater burn-out in one or more of the series-connected low level tubes—and a burn out in one of these heaters, however caused, will leave the no-load plate supply voltage between the heater and cathode of each tube remaining on the supply side of the burn-out.

The other alternative—a separate rectifier to supply the low-level heaters—may be provided in several ways, each of which in large measure avoids the first objection listed for the series plate-supply scheme, and completely avoids the others. With presently available surplus transformers, selenium rectifiers and chokes, and with standard components not much more expensive, a separate d.c. heater supply is both practical and economical.

Typical Circuits

Basic circuits for d.c. heater supply are shown in *Fig.* 1. The plate-supply connection is diagrammed at (A). With a string of n 12-volt heaters (150 ma) the voltage drop from X to $B-$ will be $12.6n$, and the resistors R_1 and R_2 are selected to provide this condition. If the normal plate current drain is less than 150 ma. $R_2 = 0$, and R_1 is adjusted to give the 150-ma current through the heater string. If the normal plate current is over 150 ma, R_1 is adjusted to draw a few ma (as a safety bleeder across the plate supply filter) and R_2 is adjusted to by-pass the excess current. Adjustment in either case may be made with a milliameter in the heater loop or with a voltmeter between X and $B-$. The available plate-supply voltage between $B-$ and $B+$ will be the supply voltage across X Y less the drop between X and $B-$ in the heater loop.

Figure 1 (*B*) is the wiring diagram of a separate heater-supply unit shown in *Fig.* 2, built by the author as a stand-by and bench unit. A 110/110-volt isolation transformer supplies a half-wave selenium rectifier followed by a capacitor-input filter. a load-adjusting resistor, and a safety bleeder. The unit will supply one to six 12-volt, 150-ma heaters—the load-adjusting resistor being set to the

[*Continued on page 36*]

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AUDIO IN THE DEFENSE EFFORT

Ultrasonics in the Loran Trainer

PHILIP D. STAHL*

Part 2. Continuing the description of a unique device used for classroom training of personnel in the operation of loran navigation receiving equipment.

THE SUBSTITUTION of ultrasonic waves in air for transmitted radio signals was outlined in the previous article. The simulation of one type of signal for another demands certain specific requirements in the transducers.

Referring again to (B) in *Fig.* 8, the ultrasonic waves caused by the vibration of the diaphragm pass through the doughnut-shaped opening (Y) in the clamping plate (*18*) down to the parabolic reflector cone (*2*). The choice of this type of a reflecting surface is dictated by several important factors. First, the propagation requirements of the transducers for ground waves and sky waves; and second, the fact that the absorption of ultrasonic waves in air for sky waves is greater than that for ground waves due to the longer paths taken by the former. Typical ground- and sky-wave propagation is shown in *Fig.* 9. The effect of the reflector cone is shown in *Fig.* 10. The reflector has the profile of a parabola since this curve converts parallel beams into radiation from a single point. The parallel beams from the transducer diaphragm are thus transformed into radiation from a point source. Any other type of reflector easily centered under the transducer would produce waves originating from a number of sources which would increase or decrease radiation at certain angles, thus producing a radiation pattern of erratic intensity. Since the transmission characteristic of this device must simulate that of electromagnetic transmission, compensation must be made for the absorption of ultrasonic waves in air. Attenuation of ultrasonic waves in air is greater than that for radio waves for a given distance, so the radiation density from the parabolic reflector for low-angle (far out) sky waves be greater than that for high-angle (close in) sky waves. The profile of the reflector is designed so that there is a greater density of energy reflected into low angles of elevation than into high angles. Specifically, the density ratio between the high and low angle emission is about 1.7: 1.

Another advantage of employing this type of reflector is that it can be mounted directly under the center of the transducer so that the source of ultrasonic emission is always directly under the point indicated as the transmitting station on the loran training map by the light spot emanating from the transducer light projection system.

The function of the felt covered shield (hat) is to eliminate radiation emanating directly from the transducer housing. This radiation would produce spurious pulses to be received before the desired radiation coming from the reflecting cone.

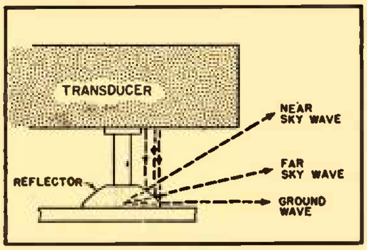

Fig. 10. Focusing effect of reflector cone.

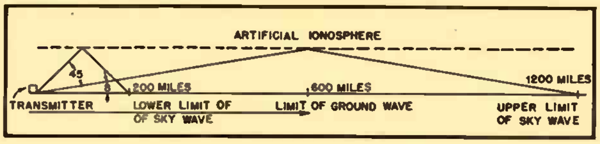

Fig. 9. Diagram showing propagation of ground and sky waves.

Sky-Wave Splitting

A phenomenon which manifests itself in electro-magnetic transmission is sky-wave splitting. Split sky waves appear as split pulses on the indicator screen and take forms similar to that shown in the upper part of *Fig.* 11. These pulses are much wider than unsplit pulses since they are the result of receiving two pulses, one slightly later than the other but close enough together to overlap. The split is the result of the different amplitudes and phase relationships of the two pulses and may be evident on any part of the leading or trailing edges of the pulse. To simulate splitting in the trainer, splitting vanes are attached to the periphery of the geared ring (*15*), which revolves slowly about the transducer. The diagrams show the patterns which appear on the indicator scope when the vanes are properly mounted and the mounting ring rotated about the transducer. Note that a blocking vane is mounted normal to the radius while a reflecting vane is mounted at an angle to the radius. At (A) the indicator scope pattern is the result of receiving the two pulses, *X* and *Y* before the blocking vane has moved into position. The *X* pulse travels directly to the receiver, while the *Y* pulse travels first to the reflecting vane and then to the receiver. Since the latter pulse travels a longer path it must necessarily arrive later and appears to the right of the *X* pulse. At (B) the blocking vane is just coming into position. The *X* pulse is now partially masked off and the received pulse becomes smaller in amplitude due to the decrease in density of the *X* pulse field. The result is a split on the leading edge of the pattern. As the blocking vane continues to move, the split moves further down the left side of the pattern until a complete suppression of the leading

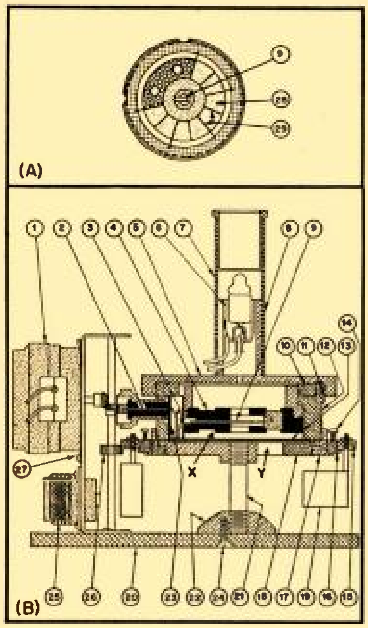

Fig. 8. (A) Plan view of crystal assembly in transducers, and (B) cross section of transmitting transducer.

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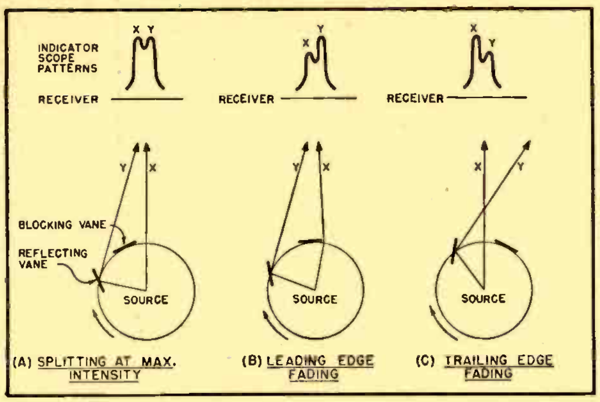

Fig. 11. Effect of splitting vanes on received sky-wave signal.

edge takes place. At (C) the blocking vane has moved out of the path of the direct ray and the reflecting beam is considerably reduced at the receiver. The result is a decrease in the amplitude of the *Y* pulse and a split moving down the trailing edge. Several pairs of blocking and reflecting vanes are mounted on the periphery of the splitting gear so that adequate splitting cycles are obtained as the gear ring rotates. It will be noted from *Fig.* 12 that the splitting vanes do not extend down far enough to interfere with the ground waves.

In order to simulate actual loran signals, the pulse radiated from the trainer must resemble a half sine wave and be in the order of 40 to 50 µsec wide at the half-power point. Because the Rochelle salts crystals exhibit more than one mode of operation and display activity on more than one frequency, problems arise in keeping the wave shape within requirements. Examination of the spectrum of resonances for the particular crystals used in the transducers shows several predominant resonances in the band from 135 to 200 kc. Exciting the transducer with a steep-wavefront voltage of the character required in this application would cause the crystals ordinarily to produce some output at frequencies other than only the major one. However, by properly adjusting the damping and matching characteristics using the castor oil, it is possible to reduce to a minimum the spurious responses of the crystals. Damping in combination with passing the received pulse from the mobile transducer through appropriate tuned filter elements in the amplifier converter, produces simulated loran signals that are exact duplicates, insofar as pulse shape is concerned, of actual loran pulses. *Figure* 13 shows typical loran pulses received at distances corresponding to ground wave and sky wave regions.

The Receiving Channel

Figure 3 shows the block diagram of the receiving section of the Loran Trainer. In the simulated loran system, the signals radiated by the transmitting transducers are picked up by the receiving transducer on the mobile carriage. This carriage is an electromechanical triangular shaped unit which acts as the aircraft and has attached to it a transducer similar to the one previously described. The differences are in the method of mounting and in the electrical function. Whereas the transmitting unit was required to convert electrical input to acoustical energy, the purpose of the mobile or receiving transducer is to convert acoustical or ultrasonic waves into electrical energy to be amplified at 175 kc thence converted to the 1950-kc channel 1 in the loran system so it can be radiated and picked up by standard receiving apparatus operated by each trainee. The speed and heading of the mobile carriage ("crab") can be controlled entirely and quite accurately from the operating console of the trainer by another electro-mechanical unit called the Carriage Drive.

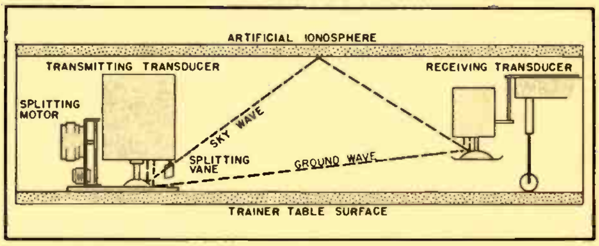

Fig. 12. Paths of simulated ground and sky waves in the trainer.

Figure 14 shows the complete simulated aircraft consisting of the "crab" and receiving transducer. The transducer is identical with its transmitting counterpart insofar as the internal structure is concerned. The dishpan reflector alters the course of the transmitted signals on their way to the receiving transducer, so that they are directed toward the latter's diaphragm. The movement of the diaphragm at the ultrasonic rate is transmitted via the castor oil medium to the crystal assembly. The mechanical stresses produced in these crystals develop corresponding voltages across them, which are then fed by coaxial cable to the input of the Amplifier-Converter unit.

The reflector cone underneath the transducer has the same parabolic profile as the one used on the transmitter and consequently the radiation characteristic described for the transmitting reflector is mathematically squared. Specifically, the radiation factors of 1.7 times for low angle (far out) sky waves for both the transmitting and receiving transducers are combined to produce an increase of about three times in intensity. It has been found that with this design, the overall transmitter-receiver system reflectors compensate for the effect of ultrasonic absorption to such a degree that for all practical purposes the ultrasonic radiation represents the same inverse square distribution as its electro-magnetic counterpart.

Figure 15 shows the carriage-drive unit which controls, from the trainer console, the speed and direction of the mobile carriage. The speed of the crab can be set from zero to 3600 nautical miles per hour while the direction is controllable over 360 deg. In addition, provision is made to simulate drift of the aircraft's heading and to correct for latitude curvature. The carriage drive can move the crab over any part of the complete loran training table which is 8×8 feet in area and represents 1,300,000 nautical square miles.

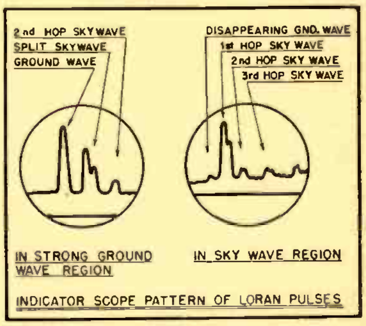

Fig. 13. Typical indicator scope patterns; (A), in strong ground-wave region, and (B), in sky-wave region.

The block diagram for Amplifier-Converter is shown in *Fig.* 16. This unit first amplifies and shapes the 175-kc signals from the mobile transducer, and then converts and amplifies them fur-

Fig. 14. Selsyn-driven mobile carriage with transducer mounted. This unit simulates aircraft or ship.

ther at 1950 kc, channel 1 in the loran system. The circuit may be divided into three major sections: First, the 175-kc amplifiers; second, a converter section which converts the 175-kc signals to 1950 kc; third, a 1950-kc tuned amplifier section which provides power to the radiating antenna and, through a low-impedance cathode-follower output, drive for the monitor equipment. The antenna radiates sufficient power so that adequate signals can be picked up by student loran sets hundreds of feet away from the trainer proper.

The purpose of the Interference Generator is to simulate any and all types of interference encountered under actual signal reception. The possible types of noises encountered are: atmospheric static, radar signals, c.w. signals, and commutator or brush noise from generators and motors operating in the aircraft proper.

The 8 x 8 foot table shown in *Fig. 2* represents the operating surface for the entire scaled down or miniaturized version of 1,300,000 nautical miles of loran service area. The table actually consists of two 4 x 8 foot sections bolted together. The table legs are mounted on adjustable castors. Thus the entire unit may be leveled so that the masonite running surface for the crab is absolutely level. Suspended 7 in. above the operating surface is the artificial ionosphere, an 8 x 8 glass surface actually consisting of four 4 x 4 sections of 3/8-in. tempered plate glass. The height of about 84 miles (seven inches) for the artificial ionosphere is dictated by the requirement that the trainer reproduce the relationship between the sky-wave path length and ground-wave path length. The difference between the two is shown to be a function of the ground-wave distance. In the case of actual loran, ground-wave distance is measured along the arc of the earth, and the sky waves are reflected from a sphere (inosphere) concentric with the earth and approximately 51 nautical miles above the earth's surface. In the trainer, however, the earth and sky are represented by parallel planes. Consequently, a compromise ionosphere height is necessary. The optimum height turns out to be about 84 miles.

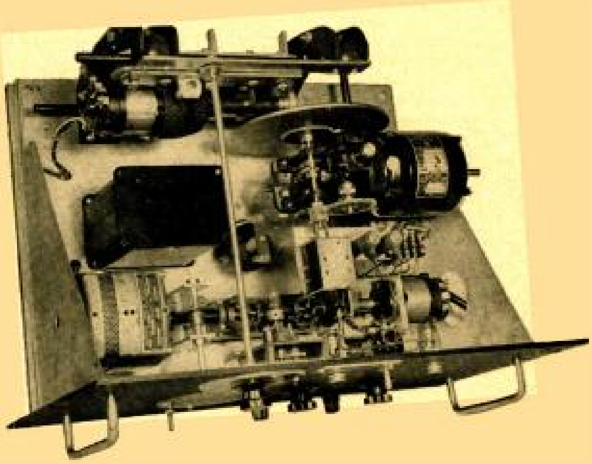

Fig. 15. Carriage drive unit, with electromechanical equipment for control of crab movement.

Conclusion

The Loran Trainer described above has the following noteworthy features of interest: A complete radio system covering a great surface area of the earth simulated and reduced to practical dimensions by substituting for the radio wave with a velocity of approximately 186,000 miles per second, an ultrasonic counterpart with a velocity of approximately 1129 feet per second. Using an eight-segment Rochelle salt crystal transducer, 175-kc ultrasonic pulses can be radiated over 270 deg. in azimuth and 45 deg. in altitude and be made to cover an area greater than 64 sq. ft. Both ground and sky waves can be simulated insofar as propagation characteristics are concerned as well as reproducing the effect of sky-wave splitting. Another transducer of essentially identical design is used as a receiving unit and after being amplified and converted to one of the loran channel frequencies, the signal is radiated to any number of trainee loran receiving sets thus performing the important task of training the maximum number of personnel in the operational use of loran navigation apparatus with a minimum of expense and technical difficulty.

Acknowledgement

The author is grateful to the Navigation Section, Special Devices Center, Port Washington, N. Y. for supplying technical manual material used in illustrating this article as well as releasing for publication the subject discussed. Appreciation is also extended to the Presto Recording Corp. for the excellent cooperation in supplying additional material based on investigations carried out in its laboratory.

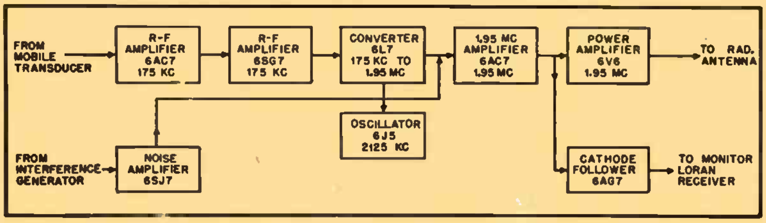

Fig. 16. Block diagram of amplifier-converter unit.

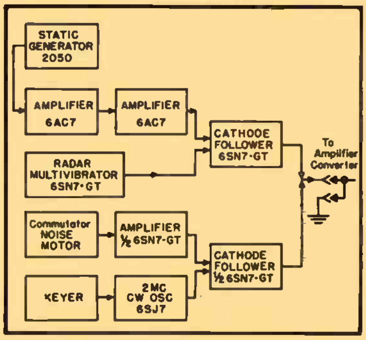

Fig. 17. Block diagram of interference generator unit.

The Effect of Sound Intensity Level on Judgment of "Tonal Range" and "Volume Level"

STEPHEN E. STUNTZ*

A discussion of the wide variety of factors which influence the conclusions derived from listener preference tests.

For many years we have been aware that changes in the physical intensity of sounds are accompanied by changes in the subjective dimension which we call *loudness*. We also know that for the normal human listener these two quantities are not always linearly related. This becomes apparent when we stimulate the ear with pure tones at various frequencies, over a range of intensity-level. *Figure* 1 will illustrate this point. Here the data of Fletcher and Munson[1] are displayed in a form enabling us to make direct comparisons between the loudness of a given frequency at several intensity-levels, or between the loudness of several frequencies at a single intensity-level. The scaling of the psychological dimension, loudness, in this figure follows the recommendations of the American Standards Association Committee on Acoustical Measurements and Terminology[2]; the term "sone" is applied to the unit of loudness measurement according to a suggestion by Stevens.[3] Intensity-level is referred to the acoustical standard of 10^{-16} watt per cm^2.

The curves shown here depict the growth of sensation magnitude with signal intensity, at a variety of frequencies.

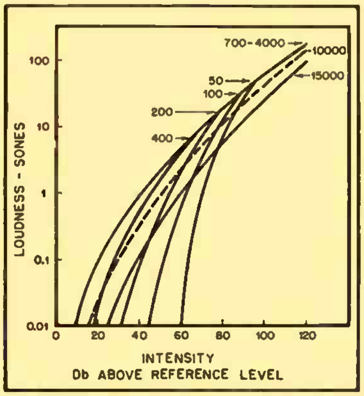

Fig. 1. The loudness function, showing how sound intensity-level (reference 10^{-16} watt/cm^2) affects the loudness of pure tones at different frequencies in the useful auditory spectrum. Frequency is shown as parameter.

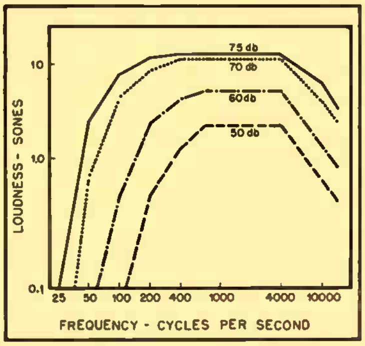

Fig. 2. An interpretation of the loudness function, showing how the over-all frequency-response of normal human hearing varies with the intensity-level of sound. Intensity-level is the parameter.

They characterize the reactions of an average listener over the greater portion of the useful auditory spectrum. Several details are worth special attention: first, that although the growth of loudness is far more rapid at low (those below 200 cps) than at high frequencies for ordinary intensity-levels, much greater intensity of sound is required at the low frequencies to initiate any sensation at all. Second, the rate of growth is not uniform for all frequencies until an intensity-level is reached approaching the threshold of feeling, that is, non-auditory sensation. Third, the loudness of frequencies in the range 700 to 4000 cps seems to be affected by intensity changes least of all. It will be recalled that the normal human ear is most sensitive to this portion of the spectrum, often called the "middle range." Fourth and last, loudness shifts at the higher frequencies (around 10,000 cps), those with which we are often concerned in "high-fidelity" sound reproduction, are not greatly different from those of the middle frequencies. In summation, these curves suggest that the ear's frequency response is to a considerable extent directly influenced by the intensity of stimulating sounds.

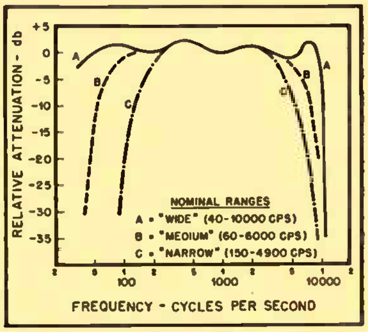

Fig. 3. Response characteristics of Eisenberg and Chinn's electrical system, exclusive of loudspeaker, used in their study of preference for "tonal range" and "volume level." (Reproduced from the Journal of Experimental Psychology, 1945, by permission of that Journal and of the American Psychological Association.)

Let us review this conclusion in more conventional terms. *Figure* 2, based on the same data as *Fig.* 1, shows directly how variations of intensity affect what might be called the normal listener's frequency response. The four intensity levels shown as parameters—50, 60, 70, and 75 db—were chosen on the basis of some experimental data which will be discussed subsequently. The implications of this figure are of considerable interest to the audio engineer. For one thing, the ear does not behave like the usual electroacoustic transducer, whose

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[1] H. Fletcher and W. A. Munson. Loudness, its definition, measurement and calculation. *J. Acous. Soc. Am. 5*, 2, 82, 1933.

Opinions and conclusions expressed in this paper are the author's own and do not reflect policies of the United States Navy.

[2] Proposed standards for noise measurement. *J. Acous. Soc. Am. 5*, 2, 109, 1933.

[3] S. S. Stevens. A scale for the measurement of a psychological magnitude: loudness. *Psychol. Rev. 43*, 405, 1936.

frequency response remains relatively unchanged over a range of intensities limited at the upper extreme by the onset of overloading. In this connection, it is noteworthy that the 75-db intensity level is far below the ear's overload limit. Therefore, we cannot say that the apparent broadening of the flat top of the curve is necessarily related to over-excitation of the auditory mechanism. Another point of importance is that when we raise signal intensity from 50 db to 75 db, we effectively add to the listener's range at 1 sone, or 1000 millisones, loudness, something over three octaves downward from 400 cps. Put another way, by raising the intensity-level from 50 db to 75 db, we render a 125-cps tone over 90 times louder for the average listener. By either statement, it is evident that a tremendous improvement of the ear's effective bass response follows a rise in over-all signal intensity. To a somewhat lesser extent, the same is true at the treble end of the spectrum, as these curves suggest. It is expected that the 50-db contour, if extended, would intersect the 100 millisone (0.1 sone) loudness ordinate just below 20,000 cps, or near the upper frequency limit of normal hearing.

Listener Preferences

Recently a number of experimenters have investigated the preference of listeners for various conditions of frequency range and intensity-level in the reproduction of music and speech. Of the several studies reported, the most extensively documented appear to be Eisenberg and Chinn's[4] and Olson's.[5] In both of these experiments, it will be recalled, listeners were required to compare consecutive passages of musical selections played through adjustable frequency filters. In Eisenberg and Chinn's study, electrical filters were employed restricting the range at both ends simultaneously. *Figure* 3 shows the three band-pass characteristics upon which their listeners based judgments of "tonal range" preference. The authors note that these curves apply only to the electrical portions of their apparatus; in discussing their results, they imply that these curves also represent conditions in the acoustical field surrounding their listeners. It will also be recalled that Eisenberg and Chinn studied preference for program intensity-level, choosing 50, 60, and 70 db as the three values for comparison. In one series of subexperiments, these three intensity-levels were combined with the three frequency pass-bands already described, and the listeners asked to state preference for the resultant condition of both "tonal range" and "volume level." As we have already seen, when a sufficient change in signal intensity occurs listeners will report an apparent change in frequency range even though no physical control of pass-band has been imposed. Now in the measurement of preferences, it is important that the conditions serving as bases for judgment be clearly discriminable to the average observer. If the differences between them be discernible only by chance, then the observer is plainly handicapped in stating his preference with certainty. Keeping this in mind, then, let us look at the effects of Eisenberg and Chinn's filters upon the auditory spectrum as perceived by an average observer under the three intensity-levels used. Returning to *Fig.* 2, we can estimate from the 50, 60, and 70 db curves the perceptual results of sound transmission through a system nominally flat from 40 to 10,000 cps, corresponding to the "wide tonal range" of these experiments. *Figure* 4 shows the subjective effect of the "medium-tonal-range," that is, 60 to 6,000 cps, filtering; it will be noted that only at the "high volume level" do the restrictions at both high and low ends become noticeable. At the two lower levels, the observer would be expected to report mainly a change in highs as a result of filtering, but a variation of both lows and highs would be reported as a result of the changes in level. *Figure* 5, showing the effects of "narrow-range," that is, 150 to 4,900 cps, filtering, suggests an opposite conclusion: here the greatest perceived differences occur at the low-frequency end as level is varied. Restriction at the high end is so severe that raising level from 50 to 70 db expands subjective frequency range hardly more than half an octave upward at 1 sone loudness. *Figures* 2, 4 and 5 indicate that a growth in the perceived range of frequencies probably occurred independently of the band-pass controls imposed by means of filters.

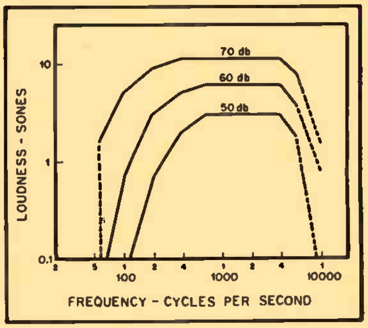

Fig. 4. Subjective effect of Eisenberg and Chinn's "medium tonal range" filters at "high" (70-db), "moderate" (60-db), and "low" (50-db) volume levels. Broken lines indicate cutoff effect of filters. Note the apparent ineffectiveness of high-pass filters at 50 and 60 db.

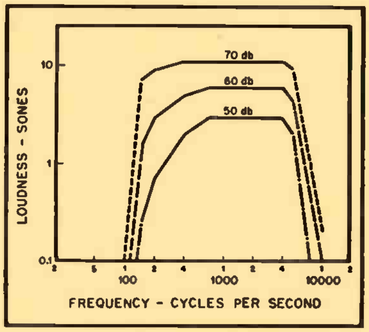

Fig. 5. Subjective effect of Eisenberg and Chinn's "narrow tonal range" filters at "high" (70-db), "moderate" (60-db) and "low" (50-db) volume levels. Broken lines indicate cutoff effect of filters. Note relative ineffectiveness of high-pass filter at 50 db, and slight effect on subjective bandwidth at high end caused by change in intensity-levels.

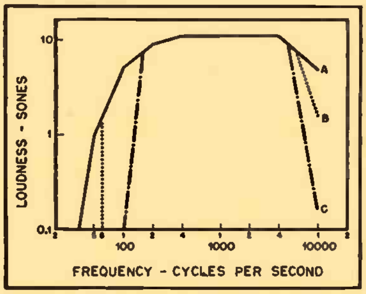

Fig. 6. Subjective effect of Eisenberg and Chinn's "wide," "medium" and "narrow tonal range" filters at 70-db intensity-level ("high volume level"). Broken lines indicate cutoff effect of filters.

In *Figs.* 6, 7 and 8 we can see the effects of filtering at any one of the three intensity-levels. *Figure* 6 suggests that at "high-volume level" the average listener would experience little difficulty discerning the shift from "wide" to "narrow" ranges, that is, from band A to band C. Likewise, the shift from "medium" to "narrow", band B to band C, probably would be easily detected. However, in comparisons of "wide" with "medium", that is, "A" with "B", discrimination is likely to be uncertain, yielding statements of preference not acceptably reliable. *Figure* 7 shows an aggravation of this difficulty, brought about by reducing intensity-level to 60 db. Here the three bands become more easily confused, although discrimination of "wide" (A) from "narrow" (C) might still be accomplished with better than chance success. *Figure* 8 presents a pic-

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[4] P. Eisenberg and H. A. Chinn. Tonal range and volume level preferences of broadcast listeners. *J. Exp. Psychol.* *35*, 5, 374, October 1945.

[5] H. F. Olson. Frequency range preferences for speech and music. *J. Acous. Soc. Am.* *19*, 4, 549, July 1947.

ture of potential confusion bordering on chaos. Here, at 50 db intensity-level, differential effects of high-pass filtering have almost disappeared. Any discrimination among the three bands must be made on the basis of changes at the high end alone. Since there is relatively little difference between "narrow" (C) and "medium" (B) for the listener (perhaps one-third of an octave above 5,000 cps at 1 sone loudness), we would anticipate largely unreliable judgments of preference for one or the other. However, the subjective difference between "wide" (A) and "narrow" (C) is more evident, and likely would produce more satisfactory indications of preference.

In the experiments conducted by Olson, intensity-level was maintained at 75 db throughout, and but two frequency-range conditions were compared—unrestricted bandwidth, and a nominal 5,000 cps low-pass. *Figure* 9 shows the physical effect of the frequency-range controls imposed in this experiment, while *Fig.* 10 represents the subjective effect of these controls. Observe that at the high frequency end this curve compares favorably with that for Eisenberg and Chinn's "narrow range" at 70 db (*Fig.* 6, curve C), while the curve representing the effect of Olson's unrestricted condition closely resembles Eisenberg and Chinn's "wide-range" curve at "high volume level" (*Fig.* 2, 70 db). From these observations we might infer that as far as the high-frequency end of the range is concerned, there was little difference between the discrimination task presented Olson's listeners and that confronting Eisenberg and Chinn's. Also, we may predict that Olson's two passbands should be easily discriminable on the basis of their subjective differences, and therefore give rise to highly reliable estimates of preference for one or the other.

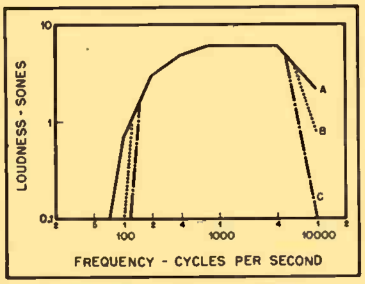

Fig. 7. Subjective effect of Eisenberg and Chinn's "wide," "medium" and "narrow tonal range" filters at 60-db intensity-level ("moderate volume level"). Broken lines indicate cutoff effect of filters.

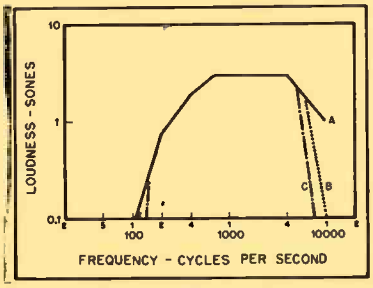

Fig. 8. Subjective effect of Eisenberg and Chinn's "wide," "medium" and "narrow tonal range" filters at 50-db intensity-level ("low volume level"). Broken lines indicate cutoff effect of filters.

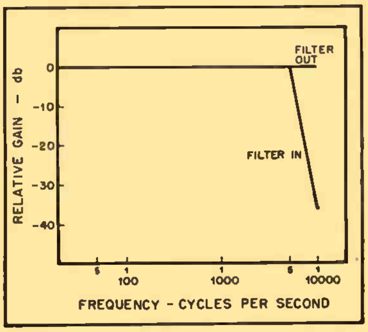

Fig. 9. Approximate response characteristic of acoustical filter system used in Olson's study of preference for frequency range, showing acoustical cutoff of "5000-cps" low-pass filter.

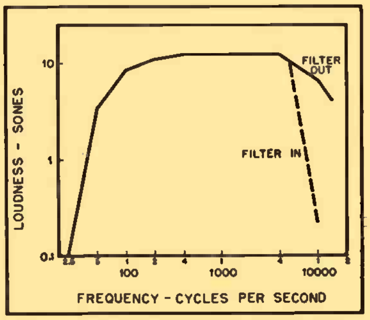

Fig. 10. Subjective effect of Olson's "wide" and "narrow frequency range" filters at 75-db intensity-level. Broken line shows cutoff effect due to filter. Note similarity between this low-pass cutoff effect and that of Eisenberg and Chinn's "narrow tonal range" at "high volume level" (70-db curve, Fig. 5).

Analysis of Tests

The published results of the two studies cited here have been analyzed for the purpose of estimating the reliability of preferences indicated by the listeners. The results of this analysis are shown in Table I. Only the preferences of the "cross-section", or unspecialized, listeners are treated, on the grounds that they are more representative of the general population than would be the judgments of, say, professional musicians, high-fidelity enthusiasts, audio engineers, or other specialists. This table summarizes only the testing in which music was used. It lists the preference-statements of whose occurrence we can be reasonably sure 99 or more times out of 100 (".01 level of confidence"). Eisenberg and Chinn's preferred combinations of "tonal range" and "volume level" appear in the left-hand columns. From their results as here interpreted, there emerge two facts of considerable importance. First, out of the twenty combinations of band-pass filtering, intensity-level, and musical content which their listeners were asked to evaluate, only the nine shown here appear to have produced adequately reliable statements of preference. This suggests that in the remaining eleven, judgment was complicated by inadequate discriminability of the conditions offered for comparison, due either to the effects of combining frequency-range and intensity-level, or to failure of the musical samples to sufficiently occupy the portions of spectrum studied.[6] The second important point is indicated by the asterisks appearing in the left-hand column of the upper table. Five out of nine of the reliably preferred combinations yield passbands which are subjectively broader than their non-preferred counterparts, although by *physical* definition they are narrower. To some extent, the authors may have been aware of this apparent anomaly, for they conclude that "the most reliable judgments were made when both tonal range and volume level were varied."[7] However, the findings reported here strongly suggest that their prime conclusion, "listeners prefer either a narrow or medium tonal range to a wide one,"[8] may deserve careful reviewing. Submitting the results of Olson to similar analysis, we do not find evidence of such contaminating factors. (Table I) Evidently the passbands and intensity-level used so unequivocally structured the judgmental situation, and were so occupied by the spectra of the musical samples chosen, that his listeners could make their choices relatively unhampered by doubt. All of the judgments rendered by his unselected listeners meet the criterion for reliability, and definitely favor wide-passband transmission over narrow.

If the preceding arguments be ac-

[*Continued on page 26*]

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[6] In designing tests of this sort, one must be aware that a mere statement of the range of frequencies which his apparatus will transmit is insufficient evidence that this range was actually occupied by the sound on which the listeners had to base their preferences. Neither of the studies reviewed in this paper makes any direct mention of the frequency content of the program material used. Some sort of spectral analysis is plainly required in order to demonstrate the physical effect of the frequency-restricting controls imposed.

[7] *Ibid.*, p. 390.

[8] *Loc. cit.*

Phono Facts

MAXIMILIAN WEIL*

A compilation of 74 simple pointers which serve as a complete training course for the person who is confronted with the problem of selecting phonograph equipment.

OF THE HUNDREDS of letters received from day to day by the writer, it is astonishing to find that such a large percentage are from readers of this magazine. It is astonishing because many of these readers are in no way connected with the field of electronics, but they have gained a good understanding of audio equipment and are more critical in selection of apparatus.

Of the many questions in the field of sound reproduction that such letters contain, the most frequent ones are answered here.

It was back about 1935 that "high fidelity" became the talk of the industry. At that time, the R.M.A. issued a definition of high fidelity as—"equipment capable of reproducing frequencies to 7,500 cps or over." This was most unfortunate, as it made *wide range* and *high fidelity* synonymous. Since then, audio equipment has been built to kilocycles and more kilocycles.

On the one hand, the purchaser buys a high-fidelity audio system in the belief that the performance will be, as claimed, one of *fidelity*. That, to the purchaser, means *faithful* reproduction. To the technician, on the other hand, it means wide frequency range in most cases.

According to the above definition, the technician is not misrepresenting, if the audio system *is* capable of reproducing a wide frequency range. At the same time, however, the purchaser is in firm belief that he is buying *faithful* reproduction. Accordingly, the deal is a sort of legal fraud, with both parties innocent of it.

Let us cite a few actual cases:

Mr. Smith, who had just bought a high-fidelity audio system on sales talk such as "crisp," "sharp as a razor," "you can hear the resin on the bow," etc., is much disappointed and disillusioned.

Says Mr. Smith, "It sounds very unpleasant. I decided to check up and went to a concert. At the actual concert, the music I heard was not 'crisp,' not 'sharp as a razor,' I didn't hear the resin on the bow and, what's more, I didn't want to." Smith then puts the treble-control to work, cutting off a lot of kilocycles for which he paid that extra money.

Take the case of Mr. Newman, who just paid over $650.00 for a high-fidelity system. He is disappointed and complains. The seller answers, "This is 'high fidelity', you must become used to it . . . ." Mr. Newman says, "That's nonsense, no one has to get used to it when at an actual concert and that is the real thing, Mr. High Fidelity himself."

The term high fidelity, as used in connection with audio apparatus, has always seemed to me unfortunate. Why *high* fidelity? Sounds very much like the man who keeps emphasizing that he is *highly* honest—as though there were different degrees of honesty.

Here is a quick test: Compare two pickups A and B of different make but whose wide-frequency characteristics are substantially the same. One will be found to perform with *fidelity*, with pleasing musical quality while the other will be harsh, strident, shrill. Yet, both have the same range.

It is now generally conceded that mere extension of frequency range does not, by itself, result in faithful reproduction.

The interchangeable use of *high fidelity* and *wide frequency range* is probably rooted deeply by now. However, for the good of the audio industry, high fidelity should be redefined in order to stop continued misunderstanding.

Pickup Pointers

1. Of two singers covering the same range—each capable of reaching "High C"—one may be pleasing, the other just the reverse. With reproducers of different design, *both wide-range*, one will be pleasing, the other harsh.

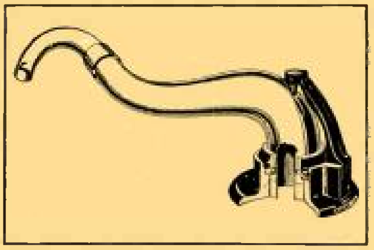

Fig. 1. One of the latest developments in acoustic tone-arms—that used on the Orthophonic instruments of the mid-twenties.

2. Most critical factor in a reproducer is vibratory momentum.

3. The larger the vibrating mass, the greater the vibratory momentum.

4. At the comparatively low frequency of 1,000 cps, the vibrating mass has to make 2,000 reversals per second—a terrific rate. But, before it can reverse in direction, it has to come to a stop, and the record groove does the stopping.

5. Obviously, the tinier the vibrating mass, the easier and cleaner the reversal and the less the "hangover."

6. Hangover causes the worst type of distortion.

7. Needle radiation is caused by stylus itself acting as a diaphragm. However, such radiation is very small and can be heard only when very near to it. Hold a steel needle, loosely, between thumb and forefinger, play it on a 78 r.p.m. record. The sound heard will be due to needle radiation.

8. Needle talk or needle noise is due to three factors:
   a. Heavy vibrating mass.
   b. Lack of sufficient lateral compliance.
   c. Lack of sufficient vertical compliance.

9. Needle noise is produced by stylus stiffness or heavy vibrating mass, or both, forcing the record itself to act as a diaphragm.

10. Needle noise is annoying when the record player is in the same room with the listener. However, the seriousness of needle noise is in the damage inflicted on the record groove by the factors which cause the noise.

Fig. 2. Early commercial magnetic pickup, showing similarity in construction to acoustic model.

11. The constant, inexorable pounding of the groove walls will soon show itself in increased distortion and gradual destruction of the disc.

12. A practical way to judge reproducer compliance is by listening for needle-noise from across the room, when playing a 78-r.p.m. record.

13. The greater the needle-noise, the greater the *lack* of compliance or the larger the vibrating mass—or both.

14. High vertical compliance is as important as is high lateral compliance.

15. Lack of sufficient vertical compliance greatly accelerates groove erosion.

16. Twice during each cycle the stylus hits a constricted part of the groove (pinch effect) with a terrific "bang." The effect of this is similar to what happens when the dangling chain on the rear of truck bounces along the pavement.

17. The reproducer must be designed so as not to permit frontal oscillations—to and fro movement of the stylus.

18. When a reproducer possesses the desired vertical compliance, it is important that it be so designed as not to permit vertical generation. Such generation introduces second harmonic and vertical-noise distortion.

19. For the compliance to be effective, the lateral compliance of the tone-arm should be at least equal to the lateral compliance of the reproducer.

20. Science knows of no way to determine the musical quality of a pickup. As with musical instruments, it must be put to the only test that really matters . . . listening.

21. Frequency curves and other technical impedimenta are necessary guides in the laboratory. However, the important fact is that *the ear is the absolute and final judge of musical quality*.

22. The higher the quality of the pickup, the more important is correct matching.

23. In general, the higher the quality of a pickup, the lower the output.

24. Reproducing sound from disc is based on *solid* mechanical coupling between stylus-point and groove—not mere touch, but solid coupling.

25. Most popular is the belief that the

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* *Audak Company, 500 Fifth Ave., New York 18, N. Y.*

lighter the needle force, the lower the record-wear. In general, this is so down to a certain point. Reducing the needle force below that critical point will wear the record faster.

26. Even with infinite compliance, there is a definite downward limit to which the needle force can be reduced. This downward limit is determined by the point at which "groove skating" begins.

27. Reducing the needle force to the point of groove skating will result in distortion, and will damage the record rather than preserve it.

28. Tests show that as a factor in record-wear, vibratory-momentum ranks as number one. It is even more destructive than a too low needle force.

29. In general, the pickup with the lowest vibratory-momentum will have the lowest distortion and the least record-wear, other things being equal.

STYLUS

Much has been written on the subject of styli the past few years. Twelve years ago, there was an organized effort put behind the sale of "permanent" points (jewels) for use with pickups then in the homes. At that time the writer stated . . . .

> "It is safe to say that more than 90 per cent of the pickups now in use will not work properly with a jewel-point. Any attempt to use a jewel-point with such pickups will result in serious injury to the record."

This was an understatement, if anything. Yet, thousands of jewel-points were sold for use with such pickups (needle force ⅛ to ¼ pound), ruining hundreds of thousands of discs. These styli were sold for as high as $50.00 each, net.

About four years ago, in an attempt to post the unsuspecting buyer, the writer decided on a lone crusade against the unscrupulous sale of "permanent" points. For several weeks, advertisements were run in 22 of the leading newspapers throughout the country. The cost of this campoign added up to a substantial figure. Apparently someone was being hurt by this campaign, for in October, 1949, the Federal Trade Commission called on the writer for details and explanations of the facts on which this campaign was based.

Some months later, the Commission issued injunctions ordering the vendors of jewel points to desist from making any further claims as to the number of plays, etc.

Stylus Pointers

30. *How many records can be played with a given jewel point?* This is one of the most frequently asked questions. Figures ranging from 2,500, 5,000, and even 10,000 plays have appeared in sales literature.

This is an important question and cannot be answered directly. It is like asking "How many miles of wear can be obtained out of a pair of shoes?" It will depend on the kind of shoes they are, of course, the weight of the person wearing them, the nature of the walk and—most important—the nature of the ground walked upon, such as gravel, concrete, grass, etc.

The number of plays obtainable from any jewel point depends on the kind of jewel and on the needle force. It further depends a great deal on the reproducer with which the stylus is used, the arm structure, and the nature of the material of which the record is made—this latter being especially important.

31. A jewel point that is good for 184 hours play in one case may last only half that time or even less, when used with a different reproducer, different arm, different discs, etc.

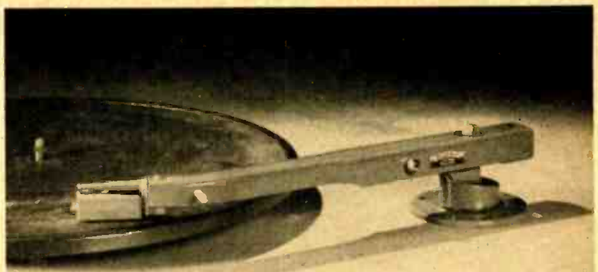


Fig. 3. Modern high-quality magnetic pickup which provides for playing of two different groove widths with a needle force of 6 to 8 grams.

32. It is important for the stylus point to have correct radius for the particular use intended. For LP discs, a radius of .001 in. will give the best results; for 78 r.p.m. records, a radius of .0028 to .003 will give best results.

33. It is highly important for the stylus point to have the greatest degree of polish the particular jewel is capable of acquiring.

34. The included angle should be between 45 and 50 degrees.

35. With the advent of pickups with a needle force of 12 grams or less, the diamond has come to the fore as a desirable stylus.

36. The use of sapphire or diamond must be decided for each particular case. Each has some advantage over the other.

37. The natural sapphire is capable of acquiring extremely high polish.

38. The National Bureau of Standards rates the diamond as 4½ times as hard as the natural sapphire.

39. A diamond point will last longer than a sapphire point. However, *no* jewel point is permanent, be it diamond or sapphire. Therefore, periodic replacement is necessary for good reproduction and if the discs themselves are to be preserved.

40. A diamond is good for many more plays than a sapphire. However, there is no difference in the actual musical results, everything else being equal.

41. The musical performance with a compromise stylus-point will be—just as the name implies—a *compromise,* at best.

42. In the case of stylus-assemblies, the mounting of the jewel is but a small part of the procedure. The complete stylus assembly must then be *laboratory calibrated* for proper frequency response, etc.

43. *How does the user know when to change the stylus?* This is a question that keeps coming up over and over again. Here is a quick and simple method that will give a positive indication of the stylus condition:

> Obtain a lacquer disc with unmodulated grooves cut on both sides of it—one side for a 3-mil stylus and on the other for a 1-mil stylus. Both types of grooves may be on one side of the disc. Whenever in doubt, play two or three grooves on this disc. If the stylus leaves the grooves unchanged in luster and smoothness, you may be sure it is in good condition. If, however, the groove walls show score marks or any other difference when compared with the unplayed grooves, you will know that the stylus needs replacement. An ordinary magnifying glass will be of assistance.

This method is simplicity itself. It does not require dismounting of the pickup or removal of the stylus. It actually demonstrates itself.

TONE ARM

In the old acoustic phonograph, the tone-arm had several highly important functions to perform. It was the connecting link between the reproducer ("sound-box") and the horn. This linkage had to provide lateral and vertical movements for the arm. At the same time these linkages had to be fairly air-tight. The tone-arm had to transmit the total acoustic energy generated by the reproducer diaphagm. It had to act as an acoustic pre-amplifier and it had to maintain a pre-determined relation between stylus and record groove.

Arm resonance—the great destroyer of record grooves—is observed only when sufficient initial exciting energy at the critical frequency is transmitted to the arm.

The stylus in the acoustic reproducer possessed great stiffness—very, very low compliance—and transmitted to the arm a large percentage of the stylus-generated vibratory energy. To avoid devastating resonance, damping was introduced between the reproducer and the arm to minimize exciter-energy from reaching the arm.

Tone Arm Pointers

44. In electronic sound reproduction, the arm has only one function—to maintain the stylus in a pre-determined relation to the record grooves.

45. The arm structure and assembly should be such as to introduce no restraint to the free travel of the stylus across the disc.

46. The greater the length of the arm, the better.

47. The greater the distance between stylus-point and the vertical pivots, the smaller the *change* in the angle of incidence between stylus and record groove.

48. The greater the distance between stylus and vertical pivots, the less the pitch-distortion due to turntable wobble, record warpage, etc.

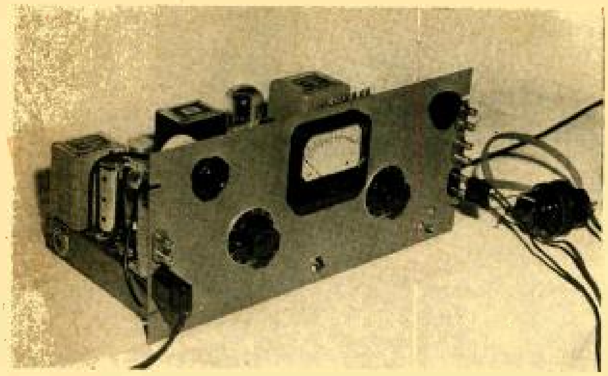
49. Up and down movements due to pinch effect and small record surface irregularities, as well as minor eccentricity, should be absorbed by the vertical compliance of the stylus itself. A stylus capable of absorbing such movements frees the record from having to lift the total mass of the reproducer, practically eliminating record wear caused by this action. This is highly important because, no matter how light the reproducer, its total mass is considerable when compared to the tiny stylus point.

50. Since the tone arm guides the reproducer across the disc, it is important that the lateral arm compliance be at least equal to the compliance of the reproducer.

51. Where spring counterbalance is used, it should be checked periodically, preferably seasonally. This is an important factor with a highly-sensitized reproducer working with a needle force of 10 grams or less. A tiny variation of 4 or 5 grams means a variation of 50 per cent, resulting in groove skating and distortion.

52. For obvious reasons, the simpler the arm and the fewer the component parts, the better.

[Continued on page 34]



Versatile Amplifier from Junk-Box Parts

CURTISS R. SCHAFER*

Construction details for a unit which will find myriad uses in laboratories, shops, and in industrial plants which are involved with audio and acoustical equipment.

Small electro-acoustic laboratories are incomplete without several instruments which will serve a variety of uses. Sometimes a pre-amplifier is required which will add no significant distortion or noise; sometimes it is necessary to measure sound level or power output, or to run a curve on a new loudspeaker or pickup cartridge. In the home, we may wish to listen to records through a good pair of headphones without disturbing other members of the family.

About a year ago, an amplifier was designed for just such a variety of uses, and built from parts taken from an overstuffed "junk-box." Compromises which might interfere with the optimum performance of any of these functions were not made. This amplifier has been used as:

1. A wide-range, low-noise pre-amplifier, from 25-ohm, 600-ohm, or high-impedance sources into 600- and 50-ohm loads.
2. A VU and db meter, with or without amplification.
3. A sound-level and sound-pressure meter. In the former application, it was used with a good microphone and ASA weighting networks.[1] In the latter, a small condenser microphone and Sanborn amplifier were fed into the high-impedance input of this amplifier, and the combination used to measure the radiation patterns and single-frequency efficiencies of loudspeakers. (The super-high-fidelity gang may be interested to know that the W.E. 640-A makes an excellent tweeter which is very clean right up to 100 kc.)
4. An ideal setup for auditioning records, and monitoring the cutting of acetate transcriptions. It is used with the W.E. 711-A moving-coil headphones shown; these phones, incidentally, were not out of the junk-box but were selected for their low distortion, excellent transient response, and the absence of peaks in their frequency response curve.[2]
5. A pure-tone audiometer in conjunction with a good oscillator and the 711-A phones, and a speech-tone audiometer with speech-test records.
6. A sensitive, logarithmic vacuum-tube

[*Continued on page 26*]

TABLE I

TUBE and TRANSFORMER SUBSTITUTIONS

V_1, V_2	6J7, 6SJ7,6AU6, 5879
V_3	Triode-connected 1603, 6J7, 6SJ7, 1620, 6AU6, 5879
V_4	6X5, 6X4; 5Y3 if 5-v. fil. winding is available on T_4
V_5	OC3/VR105, OB2
V_6	6J5, 6C4
	Triode-connected 6J7, 6SJ7, 6AU6, 5879

	T_1	T_2	T_3	T_4	L_1	L_2
ADC		A-1921				
Chicago	BI-1	BO-1	BO-1	PCC-85		RC-1585
Peerless	K-251-Q	S-215-Q	S-215-Q	R-400-A		C-305-A
Stancor	HF-20	WF-34	WF-34	P-4079		C-1420
Thordarson	T-20A05			T-22R32	T-9009	T-20C53
Triad	HS-1	HS-50	HS-50	R-11A		C-7X
UTC	LS-10 HA-100	LS-27 HA-113	LS-27 HA-113		LS-94 HC-116	CG-44

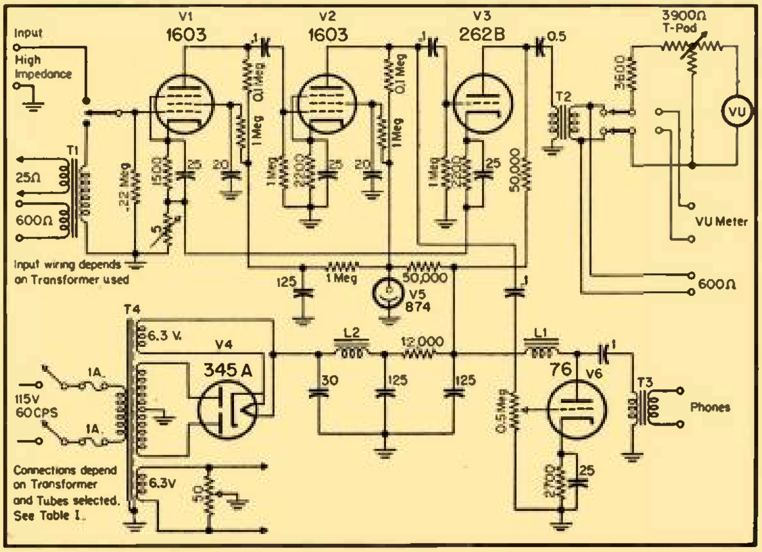


Fig. 2. Overall schematic of the amplifier described. Refer to Table I for list of substitute transformers and tubes which may be employed in this unit.

---

* *Route 4, Ridgefield, Conn.*

[1] Leo L. Beranek: "Acoustic Measurements;" Wiley, 1949, pp 224-9.

[2] Wente and Thuras; Moving-coil telephone receivers and microphones; *Bell Sys. Tech. J.*, Oct. 1931, pp 565-576. Also *J. Acous. Soc. Am.*, July 1931, pp 44-55.

it's PRESTO around-the-clock at Nola Recording Studios

Studio Manager
Tom Nola impressed
with Presto's quality
performance under
heavy schedule

Fifteen years ago the now famous Nola Recording Studios opened for business with a hope, a prayer . . . and one early model Presto recorder. Today the New York studios occupy 40,000 feet of space including an entire floor in one of Broadway's good size office buildings and a branch studio in Steinway Hall. From nine in the morning until after midnight the outstanding stars of show business parade through the studios and record their talents on a battery of Presto machines.

The basic equipment used includes Presto 14-B disc machines, Presto 92-A recording amplifiers and Presto 41-A limiting amplifiers. For playback purposes and re-recording, Presto 64-A transcription turntables are employed, while Presto "Green Label" discs are standard equipment also. Says Manager Nola, "The faultless performance of all our Presto equipment which is in use almost continuously has been a big factor in our growth and success. That's why we're a Presto studio."

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IN CANADA: Walter P. Downs, Ltd., Dominion Sq. Bldg., Montreal, Quebec   **OVERSEAS:** M. Simons & Son Co., Inc., 25 Warren Street, New York, N. Y.

RECORD REVUE

EDWARD TATNALL CANBY*

With a Tight Skirt

THE INTERMITTENT SERIES of ruminations in this space upon problems of after-the loudspeaker reproduction has brought in more correspondence (and more ideas per page) than any other subject I've tackled—except perhaps the now very dead issue of "fuzziness" in LP's. It would seem to me that the final acoustical phase of sound reproduction is an area which, in comparison with the treatment of all other phases, is still in its infancy, and this in spite of innumerable studies in the past and innumerable official and unofficial investigations now rampant. Things are just beginning to warm up. We have concrete and basic improvements already available in the spreading number of variously hornloaded and corner-mounted speaker enclosures—improvements that are as basic, I'd say, as the introduction of the magnetic pickup or the PM speaker to general home use. Yet in these latter cases there is not too much left to do, relatively speaking; more polishing, more perfection in detail perhaps. Whereas the post-speaker control of sound is still wide open, and a thousand and one ideas are floating about energetically, from holes in walls to fountains and columns of sound and what-not.

We are far from the end, I repeat, in the way of post-speaker theory and practice. Corner mounting has become semi-universal amongst high-quality-audio fans, and the results, even without horns, are excellent—due largely to post-speaker acoustical effects. Systems of reflection, replacing the time honored point source, are now becoming widely desirable in the hi-fi man's realm—and reflection is strictly a post-speaker affair. What next?

A Room for the Speaker

I don't think it is too much to suggest that we should now seriously consider our listening rooms as a vital part of our reproduction chain, subject to design and adaptation with good sound in view. There have been living rooms built around a speaker. There should be more. A mammoth device such as the larger horn-loaded systems positively requires an adequately large and rightly designed room with the proper liveness in order to function at all—nothing is more preposterous than one of these elephantine bass-producers situated in a small apartment, where a complex of unendurable standing waves and too-close reflections makes hash of good music.

A correspondent—to touch on another angle—suggests what has often occurred to me as an interesting possibility in the quest for realism; make your recording *dead*, as dead as possible; then play it in the proper acoustical conditions to produce a real binaural-style liveness through multiple reflection in the listening room. Only trouble with this is, of course, one would have to have a different room for every type of music, from solo to full orchestra! At least it theoretically solves the endless problems of double liveness—in the recording and in the reproduction—a problem that is far greater in practice than most of us have been willing to admit.

Space vs. Bass

One more line of thought before I stop. The only thing that has seemed even more impractical than designing an ideal room around a speaker has been the designing of an ideal enclosure—from the wife's viewpoint—around the same speaker; i.e., an enclosure somewhat less bulky than an automobile crate, preferably the size of a hat box. Everything else can be miniature and hi-fi too (except perhaps the output transformer and even that isn't big; it's just heavy). But speaker mounting? Not a thing you can do, and have all the bass too, we are told.

However, the newer types of enclosure have started off a lot of experiment in space-work. The heavy box full of plain air is already on the way out in favor of ingeniously folded and flared horns, bettering the space-vs.-bass ratio by quite a bit, getting a lot better distribution of sound source too. But more is in the wind than this, judging from some breath-taking experiments I've been allowed to look at and listen to lately. More later, when things ripen—but I'll drop this much to tantalize you. How about a speaker system (two-way) with smooth bass radiation down below virtually all present 15-in. fancy enclosures, one on which your wife can sit down gracefully with a tight skirt? I've

[*Continued on page 30*]

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

Pops

RUDO S. GLOBUS*

NOW THE POSSESSOR of a brand-new house and a brand-new TV monster, I am entitled to take a crack at a pops problem which is brand-new and covers an area which transcends, at points, both pops and pop recordings. However, in a devious way, it leads back to the subject matter of this column, revealing some hitherto obvious elements in the pop industry.

I am appalled at video audio (I like the rhyme of video audio, but not the thing itself). My major brand set (it came with the house) features an audio circuit which makes a scrap heap look like a Rolls Royce. Despite this melange of audio crudities, the stuff that is fed into it makes my blood run cold. It is not within my province to deal with the actual pickup at the studio (although I would fondly cherish the chastisement of the engineers on a lot of video dates). I am rather concerned with the kind of musical organization that is making its fiendish tradition a hallmark of video pops. Where the freaks who play these dates are found, I don't know. . . or rather, to be perfectly frank about it, I do know. I have watched and listened to scores of budding vocalists cringing under the impact of accompaniments which are in the wrong key, off-beat, and playing an approximation of the harmonic progressions that are supposed to go with the numbers. Clinkers, simple and pure mistakes, basic inability . . . all are characteristic of the major musical combinations that video has resuscitated from the musicians' junk heap.

One of the explanations involves the use of doublers to excess. The doubler, a particular freak of our freaky age, is a guy who plays anywhere from two to twenty instruments badly. His questionable skill as a jack of all trades allows for obvious economies (the usual, why hire thirty men when five will do?).

[*Continued on page 31*]

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"... thanks for shipping the stylus. It is now in use, and serves as a constant reminder of the *electronic magic* . . . wrought in the POLYPHASE pickup. I am gratified, but not surprised. Mr. Weil's sensible views on sound reproduction, quoted in April "Atlantic Monthly", lead one to expect . . . artistically satisfying music, which one actually gets from POLYPHASE . . . it is refreshing to possess at least ONE unit designed with more than electrical efficiency in mind."

FROM A LETTER

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have won the acclaim of thousands of users everywhere—Never before such EAR-QUALITY, such FAITHFUL REPRODUCTION but . . . after all the reams are written about kilocycles and other laboratory data—when the chips are down—you and only you can decide what sounds best and most pleasing to your ears. Therefore . . . SEE and HEAR POLYPHASE —and you be the judge.

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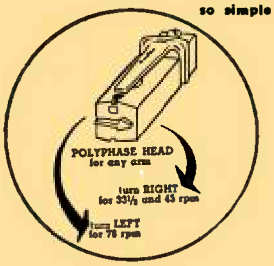

One single magnetic unit plays all home records—Sapphire or Diamond styli. Special models for radio stations, including a Vertical-Lateral unit.

SOUND INTENSITY LEVEL

[*from page 28*]

TABLE I

Tonal Range/Volume Level Preferences Significant at or Above .01 Level of Confidence

From data of Eisenberg and Chinn (1945): unselected listeners

PREFERRED COMBINATION

TONAL RANGE	VOLUME LEVEL	TONAL RANGE	VOLUME LEVEL	MUSIC TYPE
* Narrow	Moderate	Wide	Low	Classical
Narrow	Moderate	Wide	High	Classical
Narrow	Moderate	Wide	High	Popular
Narrow	Moderate	Wide	High	Light Classical
* Narrow	High	Wide	Moderate	Classical
* Wide	Moderate	Wide	Low	Classical
* Narrow	Moderate	Narrow	Low	Classical
* Wide	High	Wide	Moderate	Classical
Narrow	Moderate	Narrow	High	Classical

* Range-level combination which gives subjectively greater frequency passband than non-preferred combination.

From data of Olson (1947). Unselected listeners

PREFERRED FREQUENCY RANGE	TYPE OF MUSIC
Wide	Popular
Wide	Semiclassical

ceptable, then we may postulate a considerable similarity between the results of Eisenberg and Chinn and those of Olson. This similarity would be even more apparent, we might predict, had certain of the physical controls of Eisenberg and Chinn been more rigorously applied.

ADDENDUM

It is often observed that the disagreement between Olson's and Eisenberg and Chinn's results is due to a possible inherent difference between listening to music transmitted acoustically direct from its original source and listening to the same sounds played through a reproducing system. Up to now this criticism has been offered without empirical support, indicating a gap of crucial significance in the case for wide-range sound reproduction. A research group headed by H. F. Olson at the Princeton laboratories of RCA is currently collecting data to determine whether listeners' preerences based on directly transmitted sound are comparable to those based on reproduced sound.

VERSATILE AMPLIFIER

[*from page 22*]

voltmeter for running frequency response curves on amplifiers, pickup cartridges, and microphones.[3]

Description

Basically, the unit consists of a stable amplifier plus a standard VU meter with scale "A". This combination may seem to resemble an existing vtvm which incorporates a logarithmic pole-shaped meter, but it has several advantages which are important in electro-acoustic work. First, a balanced full-wave rectifier is required if a true indication is to be obtained from an unsymmetrical speech wave. Most speech and music waves are unsymmetrical, and if a full-wave rectifier is not used, reversals of the leads to the meter will give alternately higher and lower readings, neither of which is the true one.

Second, phase distortion in an amplifier, microphone, or phonograph pickup, although slight, will change the wave shape of peaks in the program material, and cause serious errors if the rectifier is not of the root-mean-square type. (Most commercial vtvm's are calibrated in r.m.s. scales but actually indicate peak voltages.)

Third, the dynamic characteristics of this VU meter permit accurate and standard-method monitoring of speech and music. The meter has been discussed in detail in two earlier papers.[4,5] The traditional temperature errors of copper oxide rectifiers are here reduced to a maximum variation of 0.1 db. for temperatures between 50° and 120° F. The harmonic distortion introduced by bridging the meter across a 600-ohm line is less than 0.2 per cent r.m.s. The frequency characteristic is uniform within 0.5 db from 25 to 16,000 cps. The scale zero is equivalent to a steady sine-wave input of 1.228 volt r.m.s. applied through 3600 ohms in series with the meter. This represents 4 db above a reference level of 1 mw in 600 ohms.

With regard to noise and microphonism, type 1603 tubes still compare favorably with anything of later vintage, and they are used here in the first and second stages. A W.E. 262B was selected for the third stage principally because the ADC 1921 transformer was designed to work out of this tube. A parallel output tube, the 76, feeds the phones. Table I shows possible substitutions for tubes and transformers.

The two pairs of binding posts at the left edge of the panel are the high-impedance and 600-ohm inputs, either of which may be selected by the switch in the upper left corner. The 25-ohm terminals are intended for the low-impedance dynamic microphone which is used with this amplifier, and these terminals are in a microphone input receptacle on the left side of the chassis.

The 711-A phones, of 50 ohms impedance, may be plugged into the pair of binding posts at the lower right. The upper two pairs permit connection to the output of the amplifier, either with or without the VU meter, or the use of the VU meter alone for power level measurements. On 600-ohm circuits, the bridging loss of the VU meter is approximately 0.3 db.

The overall gain, from high-impedance input through 600-ohm output, is 70 db. Noise and hum are about 70 db below the maximum output level of 100 mw. The frequency response of the amplifier alone is ± 1 db from 20 to 20,000 cps, but this frequency range may be extended about an octave on each end by careful choice of transformers for the tubes employed, and by careful construction practices. For all measurements made with this equipment involving steady-state sine waves, the number of VU indicated is numerically equal to the number of db above or below the reference value of 1 milliwatt.

In measurements involving speech and music, no db equivalent is obtainable, and all these measurements must be expressed as VU. The advantage of this system is that the dynamic characteristics of the meter used are standardized, so that measurements made on speech and music circuits in one laboratory may be more accurately correlated with similar measurements made in another laboratory or in the broadcast studio.

The prospective constructor will probably find acceptable substitutes for many of the components indicated by trade names on the schematic. However, he should be sure of the frequency response and harmonic distortion ratings on the transformers he may select. Other components, with the exception of headphones and microphones, are not critical. The general chassis layout is indicated in *Fig.* 1, while *Fig.* 2 is the schematic of the entire unit.

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[3] Wente and Thuras: High efficiency receiver of large power capacity; *Bell Sys. Tech. J.*, Jan. 1928, pp 140–153.

[4] Chinn, Gannett, and Morris: A new standard volume indicator and reference level; *Proc. I. R. E.*, Jan. 1940, pp 1–17.

[5] Affel, Chinn, and Morris: A new "VI" and reference level; *Electronics*, Feb. 1939.

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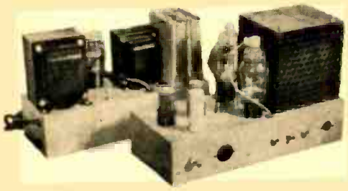

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Meissner 8CC Tuner
Bell #2145 Amplifier
Webster #100-27 Changer with Dual G. E. Cartridge
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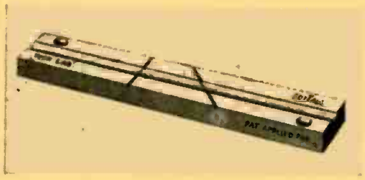
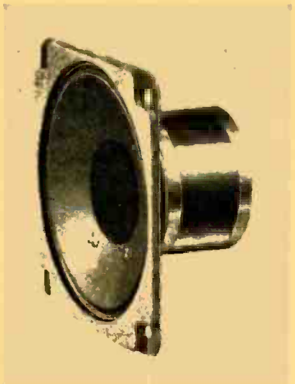
• **Miniaturized Microphone.** Offered to the industry as the smallest uni-directional moving-coil dynamic microphone, the new Shure Model 558 Unidyne is approximately one-half the size of its companion in the Shure line, the widely used Unidyne Model 55. The little Unidyne retains all of the directional qualities of the larger model, and has high over-all efficiency and smooth frequency response. Manufacturer is Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill.

• **Tape Splicing Block.** Editing of magnetic tape is facilitated by the new Editall Splicing Block recently announced by Tech Laboratories, Inc., Palisades Park, N. J. Designed by Joel Tall, and based on his years of experience as tape editor for CBS, the block eliminates the use of holding clips or other similar devices, thus permitting the operator to attain greater editing speed with reduced fatigue. The block is sturdily made of Duraluminum. Bulletin available on request.



• **Intermodulation Meter.** Although relatively low in cost, the new Model 165 intermodulation meter manufactured by Audio Instrument Co., 133 W. 14th St., New York 11, N. Y., is capable of performing precision tests on recording and broadcast equipment, also is well suited for laboratory application. Exceptional compactness permits signal generator, analyzer, and voltmeter all in a single unit. Panel size is 8¾" × 19". Residual intermodulation is below 0.1 per cent. Standard high frequencies produced by internal oscillator are 2, 7, and 12 kc. Low frequency provided internally is 60 cps. Both 4:1 and 1:1 ratios of low- to high-frequency voltage may be used.

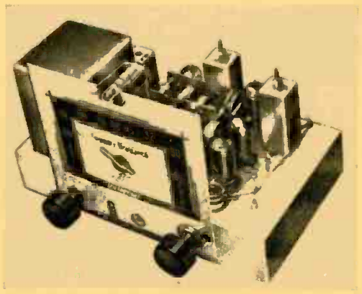
• **PM Loudspeakers.** Featuring miniaturization of design, the new Elac series 2P speakers are only 2½ in. in diameter and contain a 2.4 oz. Alnico magnet. Although intended principally for use in sound-powered equipment such as intercoms, the speaker is well suited for use in portable receivers. Heavy electrical damping and low-resonance diaphragm result in remarkable reproduction from a speaker so small. Manufacturer is Electro Acoustic Industries Ltd., London, of which U. S. sales representatives are British Electronic Group, 366 Madison Ave., New York 17, N. Y.



• **Playback Equalizer.** Users of the G-E magnetic cartridge may compensate for recording curves of domestic and European recordings by means of the Type HL 1-6 playback equalizer now being distributed exclusively by Radio Shack Corp., 167 Washington St., Boston 8, Mass. The unit is an inexpensive passive network utilizing a 6-position selector switch. Each position closely approximates one of six widely-used high-low-balance recording curves. Installation consists merely of connecting the equalizer between pickup and pre-amplifier.

• **Magnetic Sound Track on Film.** A need long felt in the sound film field is met commercially for the first time by Magna-Stripe, a patented process for placing a strip of magnetic oxide on standard black-and-white or color motion picture film. Magna-Stripe is inert and has no effect on photographic emulsion nor on processing solution. It is claimed that sound quality obtainable from Magna-Stripe is superior to any type of optical sound track. RCA, Ampro and other projector manufacturers have produced prototype projectors which reproduce and record Magna-Stripe as well as play back optical sound in the conventional manner. Since each projector so equipped is a recorder as well and contains erase features, this means that producers of sound films can do their own recording directly. Magna-Stripe is a patented process of Reeves Soundcraft Corp., 10 E. 52nd St., New York 22, N. Y. Full technical information will be supplied upon request.

• **FM Tuner.** Automatic drift compensation and self-contained power supply are features of the new URECO Model 501 FM tuner, a high-quality five-tube unit which may be simply connected to any radio or to a separate amplifier. Circuit of the tuner comprises a stage of tuned r-f amplification, two high-gain i-f stages, and ratio detector. High-Q air-form coils are used in the r-f, antenna and oscillator circuits. Tuning is by means of a 3-gang copper-plate condenser. Illuminated dial is vernier driven. Overall dimensions are 9 × 7 × 6 in. Manufactured by Universal Television Manufacturing Co., 196 Bowery, New York 12, N. Y.



• **Speaker Cabinets.** Acoustic loading is provided by means of a folded duct in a new series of speaker enclosures recently introduced by Brociner Electronics Laboratory, 1546 2nd Ave., New York 28, N. Y. Available in models for various co-axial speaker units, the new 15C Ductflex cabinet offers extended bass response and excellent damping. The cabinet is exceptionally compact, measuring only 34½" × 26" × 17½". The speaker opening is near the top, affording good distribution of high frequencies. Available in dark brown or blonde mahogany.

• **Power Tetrode.** Availability of the British Type KT66 vacuum tube in the United States, is a recent announcement from British Industries Corporation, 164 Duane St., New York 13, N. Y. The KT66 parallels the American 6L6 in electrical characteristics, and can be used interchangeably in any circuit. Pin arrangement also is identical.

NEW LITERATURE

• **Operadio Manufacturing Co.,** St. Charles, Ill. is now publishing the fifth edition of the Sound Slidefilm Guide. Listing more than 1000 available films, the Guide includes an alphabetical title index, a list of sources from which films may be obtained, and descriptive matter covering subject material of each film. Said by the publishers to be the only publication of its kind, the Guide will be mailed upon receipt of one dollar.

• **Crest Transformer Corp.,** 1834 W. North Ave., Chicago 22, Ill. is offering free of charge a new 16-page illustrated catalog listing complete data on the Crestran line of radio, television and electronic transformers. Also listed are Crestrol constant-voltage transformers.

• **Buchanan Electrical Products Corp.,** Hillside, N. J. is currently circulating Bulletin 750, a 4-page listing of the company's "pre-SURE-connectors" for solderless splicing and terminating of electrical wires. Extremely well illustrated. Available on request.

• **P. R. Mallory & Co., Inc.,** Indianapolis, Ind. has recently published a technical information bulletin covering the company's complete line of mercury-type dry batteries. Detailed specifications of all units now available are included, as well as a technical discussion covering many aspects of battery design and application. Requests for copies should be addressed to Battery Division, North Tarrytown, N. Y.

• **Helipot Corp.,** 912 Meridian St., South Pasadena, Calif., will mail without charge a new data chart listing technical specifications of various types of Helipot precision potentiometers. Shown are electrical and mechanical characteristics, power ratings, accuracies, and a listing of single-turn and multiturn units available from stock.

• **Kupfrian Manufacturing Co.,** 245 Prospect Ave., Binghamton, N. Y. is now distributing Bulletin 5194, a listing of light-duty flexible shafts for application in the electronic, automotive, aeronautical, and industrial fields. In addition to illustrations and descriptive material, the bulletin contains an interesting discussion covering the manufacture and usage of flexible shafts.

• **Berkshire Laboratories,** 502 Lexington Rd., Concord, Mass. will mail free upon request a technical bulletin describing and illustrating the Berkshire Labmarker, a small low-cost wave-shaping device for producing time marks in cathode-ray oscillography.

• **The Radio Club of America, Inc.,** 11 W. 42nd St., New York 18, N. Y. has available a limited number of copies of its current Proceedings, an 80-page book devoted entirely to commemoration of the first short-wave transatlantic transmission in December, 1921. Contains much material unavailable elsewhere. Feeling that the book would be valued as a collectors' item, extra copies were printed and may be obtained by addressing requests to the Club. Cost is one dollar.

RECORD REVUE

[*from page 24*]

seen and heard it, and sat on it. A bit small for a comfortable seat, at that. Wow!

Debussy, Le Martyre de St. Sebastien (1911).
Oklahoma City Symphony, Alessandro; Okla. City Symph. Chorale, Frances Yeend, Miriam Stewart, Anna Kaskas.
Allegro LP: ALG 100

A pale, colorless excerpting of a few orchestral passages of this major work came out before the war—and that is all we have been able to hear of it. This complete recording, with fulsome chorus and three soloists, is a revelation, and a wonderful musical demonstration of the advantage of LP. Such a work, on a huge scale, was utterly impractical on 78's—least of all from a small company; yet only a small company would tackle it. It is mood music, impressionistic, building up an extraordinary atmosphere—and on 78's that atmosphere would have been shattered by the recurring breaks, and by the pulsing 78-r.p.m. rhythm, so damaging to slow music.

This was Debussy's last major work for orchestra, and his first including chorus since the earliest works; it is extremely difficult and obviously can rarely be performed complete. Yet after one hearing it is equally obvious that this is no mere rehash but one of the biggest and most important works he ever wrote. For anybody interested in Debussy, then, this recording is profoundly exciting, and for any of you engineers who like the Waring Pennsylvanians or equivalent, this'll be a good look-see as to where it all came from. The chorus and soloists permeate the work, the last section being unaccompanied chorus for a long period, and the blending of the vocal and instrumental elements is such as you rarely hear elsewhere. Performance is excellent, if sometimes a bit brashly American in the chorus for such ultra-Parisian music.

Incidentally, like many Allegros this is basically an excellent recording but is cut at very high levels, in this case somewhat overcut. An excellent expendable test record for groove tracking and compliance. Try the beginning of cut 3, side A, a powerful brass-and-bass-drum passage which is badly overcut. I know several professional cartridge-and-arm combinations that jump grooves repeatedly right here—but one of the standard changers, with V.R. cartridge, tracks it without jumping and one professional combination I have also will track it easily. The passage is, of course, distorted at the peaks and buzzes unmercifully—but the point at which the buzzing *begins* varies significantly with different playing equipment, quite aside from groove jumping. A useful disc to have around, though it's not likely to last very long under test!

Leroy Anderson Conducts
Leroy Anderson & His "Pops" Concert Orch.
Decca LP: DL 7509 (10")

Duplicates a few of the snazzy numbers on RCA's recent "Classical Juke Box" disc (See Æ, March) and there's not too much to choose between them, that having been a top recording too. Anderson has a light style all his own and so far I haven't got tired of it, though Coates and Gillis and other "light orchestra" composers make me fidget. The humor is delightful, the orchestral effects unusual, and the whole very musical. This has a top combination of big, deep liveness plus sharp edgy closeness.

P.S. This is a big orchestra—where did Leroy pick it up so quickly—all his very own? Maybe, just maybe, it's the Boston Pops again, masquerading under another label? Pardon me; I mean the individual players who, by pure coincidence, happen to be employed separately and individually as the Boston "Pops" (which of course is also known on some occasions, by pure coincidence. as the Boston Symphony Orchestra. When it isn't playing Anderson, which it specializes in. . . .) Who knows?

Wagner, Piano Sonata in B flat; Albumblatt; Album Sonata.
Felicitas Karrer, piano.
RLP 199-26

Beethoven, Piano Sonata Op. 31, #2 in D minor; Variations in F. Haydn, Variations in F minor.
Ernst von Dohnanyi, piano.
RLP 199-16

Two very interesting piano records. The Wagner sonata is quite amazing—sounds like early Schubert, or Weber, a quite conventional but powerful little early work (1831) indicating the trend of development in Wagner—which was from the conventionally bombastic towards ultimate originality. Albumblatt, from the 1850's and the Album Sonata, like Siegfried Idyll from the 70's, round out the picture, and are excellently played too by Karrer. Very good piano sound.

Dohnanyi, seemingly a bit stiff and eccentric in tempo, full of pianistic mannerisms, does an interpretative job that is powerful and, after some hearings, increasingly impressive. A lot more carefully worked out than it may seem at first and pianists who know the Beethoven and Haydn will find fascinating detail work in phrasing and emphasis. This is obviously a grand old man of music.

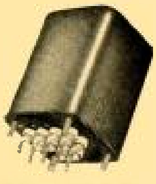
POPS

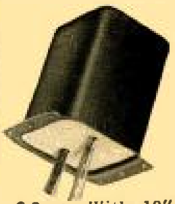
[*from page 24*]

The enormous lack of concern of our coy and posturing baby industry for the audio end of TV makes competent orchestras and competent arrangements totally unnecessary. For the most part, video dates are freelance affairs for musicians, with the usual shortcomings that result from quickie rehearsals and a general devil-may care attitude.

Stock Arrangements

Take the arrangements, for instance. Anybody who has worked the two-bit band circuit knows the story of the stock arrangement. The stock sheets are the product of music publishers who employ large staffs who turn out quick parts for general band use. Reduced to an absurdly simple level and containing the musical innovations that could be expected from a hard pressed group, the stock arrangements save the expense of hiring a full-time (or even part-time) arranger to liven up a band's desultory chore. The simplicity and banality of the stock arrangements become murderous when played by mish-mash combos with little or no skill. I have had the experience of playing stocks with bands of this sort





in small town dates, and the effect is deadly.

However, during the quiet period of the last five years, the stock arrangement has been obscured by the general failure of the standard pops business. Unless you went to a lot of small town dances played by small town bands, you didn't hear much of the boring business. Now, TV has resuscitated the stock, which with devil-may-care musicianship is productive of a larcenous combination. The accompaniment for acrobatic acts, dance teams, dog acts, dull comedy routines, vocals and even production numbers is vicious. The situation takes on a great degree of importance in view of the fact that from all indications the majority of listening time is now being devoted to video, and even with better stuff available via records, AM and FM, the effect of habit could be ruinous. As a matter of fact, recent audio history has demonstrated poignantly that audio habit does indeed exist.

Now, this contention, as usual, is going to produce a lot of pooh bahs. There is a widespread dogma, especially in the area of psychoacoustics that there is no such thing as audio habit because there is no such thing as audio memory. I, for one, maintain that audio memory does exist, if only in a relative and referrent sense.

We can reduce modern audio history to two general factions. . . so-called Hi-Fi and, to coin a phrase, Lo-Fi. Both are equally bad. . . but at least Lo-Fi doesn't attempt to dignify itself with violent statements about perfection, absolute "reproduction," etc. Both, when compared to the real thing, are way off the mark. But, we have seen the eruption of a generation trained to listen to music in terms of one or the other, or variations up and down the ladder. The Lo-Fi addict is pleasantly surprised by the concert hall. The Hi-Fi addict is horribly disappointed. In both cases, persistent listening has set standards and audio habit forms which determine the response level to what they purportedly were listening to in the first place. Both have been cheated (in some cases, advantageously). You are perfectly aware of the gross disadvantages.

But, the habit is two-fold. One is habit from pure sound aspect. The other involves the musical element. Since it is possible to train the public into the acceptance of any level of audio and musical performance when a quality is absent, the perniciousness of video pops becomes more alarming. The logical train of events goes something like this:

1. The guy who owns a television set (and recent surveys of a worthwhile statistical nature support this contention) listens rarely, if ever, to radio AM or FM—or to records. If we exclude the minority who, because of special tastes and aptitudes, continue to listen to music via radio or records, plenty of substantiation for this view exists.

2. On the basis of statement No. 1, it necessarily follows that audio habit, now including sound and musical determinations, develops through and from video-audio. The video addict, in addition, does not attend motion pictures to any great extent (or at least, infrequently) and again, with the exception of a small minority, does not attend concerts. In terms of pops, he has no place to go for jazz experience any longer, and the big pop band touring the country is out.

3. Since no area of comparison exists and since his attention is drawn primarily to the visual aspect of TV, he unconsciously accepts the audio standards as given and falls into the habit of mediocrity.

4. Keeping in mind the fact that this is

an argument directed towards the long-range point of view, the cumulative effect of video-audio will reflect back on audio in general, unless something equivalent to what happened in the radio and record industry happens to video. The tremendous strides of the past ten years in educating the public to higher audio standards (a process which is far from complete and one involving an enormous amount of heartache due to the general recalcitrance of the public and of the industry) could go kablooie within a matter of not too many years.

Pop Band Industry

Let me give you a quick sketch of what has happened to the pop industry since the war; this is a brilliant example of how quickly the descent actually occurs. From 1938 on, the pop industry was geared to a buyers market. For a band to go, a tremendous amount of money had to be spent. Any major band went through a period of as long as two years building itself up before it was ready to make money. An enormous investment to hire men, hire rehearsal halls, hire top-notch arrangers, buy time on the radio, publicize, and even buy recording dates occasionally. It wasn't only a question of building a demand for a "name;" the name had to be synonymous with a quality of one sort or another. Hundreds of bands flopped, despite fantastic financial investments. While some made the grade because of exceptional publicity work, most of them featured fine instrumentalists, fine arrangements, and a slick, professional finish that came from much rehearsing, much playing together. Goodman, Shaw, Dorsey, Miller, and the whole coterie represented quality performances. They set amazingly high musical standards.

In less than ten years, the names became myths, the bands as permanent and finished organizations disappeared. Their replacements are pick-up crews, assembled for a recording date or a quick, money-making stage show, and skillful only in the precarious ability to shuffle forth with what is in demand.

From the audio point of view, the public demanded a good, danceable beat on their records and a fairly clear presentation of solo passages. The audio demands of '38 to '45 were actually higher, in terms of pop recordings, than they are now.

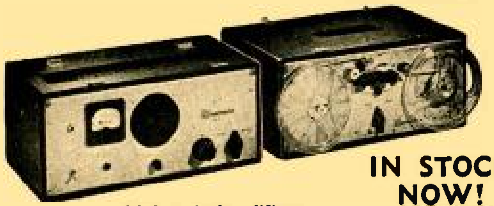
Despite this, disc jockeys have continued to play a fairly wide range of pops and opportunities still exist for some moderately decent listening. But along comes video, conquers the hearts, ears, and eyes of the country at large, and the disc jockey avenue seems inevitably doomed.

People will still want to listen to music and dance to it. When music becomes merely an accompaniment to a visual act, thereby requiring that it only conform to a vague pattern, the habit of mediocrity will have set in permanently. So long as an industry insists on feeding the public only such material as will satisfy the public, the prospects are bad. The public cannot be expected to have the know-how, technical and musical, with which to set its own standards. A responsible industry must set standards precisely because it knows better.

POT LUCK:

According to the trade, Mitch Miller made Frankie Laine a star when both were on the Mercury payroll. Now Miller is pop director for Columbia and Laine has switched to the cherry label. Whether coincidence or not, the best job Frankie has done for a long time is on Columbia 39367 . . . two weird things entitled "Jezebel" and "Rose, Rose, I Love You," the latter being translated, according to the label . . . but from what language, I don't know. Mitch backs Frankie on the Jezebel side, Paul Weston on the Rose, Rose, etc. A good job has been done by all . . . better than any of the other discs featuring the same numbers. The Rose thing is oriental, strange, and has the overtones and undertones of good old fashioned melodrama. Interesting and bouncy listening.

I am probably interfering with alien territory . . . and muchly apologize to cellmate Canby . . . but feel the urge to comment on the recent appearance of Suzanne Danco on a New York concert stage. Miss Danco, a widely heralded Belgian soprano, did a thoroughly magnificent job on the Ravel Sheherezade for the old English Decca (now London) some years back. On the basis of her vocal brilliance on discs, her New York premiere was sold out. Her live performance revealed good showmanship, adequate technical control, but a weak and strangely inadequate voice. The shock was so great to the cognoscenti who had built Danco up to empyrion heights because of the Sheherezade recording that every excuse in the books was used by way of explanation. On top of this, we are now being bombarded and hypo'd by the "new" Caruso, Mr. Mario Lanza of blacksmith fame. The valiant efforts of the M.G.M. press department are being aided and abetted by numerous pathological disc jockies who insist on playing old Caruso records and comparing them with the divine Lanza. Our only fitting comment involves a production of Wagner's Tristan with Yma Sumac singing the Isolde and Lanza the Tristan. Or better yet, have you ever considered Sarah Vaughn as the perfect Brünhilde?



PHONO FACTS

[from page 21]

53. The greater the number of loosely coupled parts (not integral with the arm), the greater the possible number of resonance points.

54. The transmission of stylus-vibratory energy to the arm can be minimized, for all practical purposes, with a reproducer having high lateral and vertical compliances. Such condition prevents development of arm resonance.

55. The old practice of loading the arm with extra "dead" weight to push the resonance-point below a given frequency or to attain resonance at a certain frequency should be avoided.

56. When used with a highly compliant reproducer, arm loading introduces distortion. Furthermore, since the extra weight has to be pushed across the disc by the record grooves, serious erosion results.

57. The "McProud test" is still the best and simplest for checking the combined tone-arm and reproducer compliance (tracking). For details, see AUDIO ENGINEERING, August 1950.

58. For years past, many attempts have been made at devising a tone-arm that would maintain tangency automatically. Patent Office records show prolific activity along that line for the past 20 years. The parallelogram idea was the basis in most of these attempts. Any such mechanism would mean an increased number of component parts and joints. Thus far, such devices have all proved themselves inferior and total unsatisfactory.

These attempts overlook the highly important fact that the groove wall would have to do all the work to keep such mechanism in tangency. This would mean serious record wear. Furthermore, since the groove wall itself has to push such mechanism into tangency, obviously such tangency would then be too late to do any good. This condition is analogous to a trolley car moving slowly around a curve. The rail has to do all the work in constantly pushing the wheels to conform to the rail-radius. Everyone is acquainted with the fact that the outside rail on a curve wears out much faster

TURNTABLE

59. The first essential in a turntable is that it maintain a constant speed, if there is to be no pitch distortion due to the speed factor.

60. A simple and most practical method of testing the speed constancy of a turntable is by playing either a piano or a violin recording with long sustained notes. Where available, playing a disc with a constant frequency note—anything from 1,000 to 3,000 cps—is an excellent method to use. The human ear is very sensitive to changes in pitch (wow).

61. Ability of a turntable to maintain constant pitch is very important. It should be checked at all the speeds that are being used in actual playing.

62. The slower the speed, the more difficult it is to maintain constant pitch. Therefore, the slow speed, 33-1/3 r.p.m., should be checked carefully.

63. Where quality performance is sought, a quality magnetic pickup is assumed.

64. Up to a few years ago, pickups were made with heavy vibrating mass for high output. High output was necessary to make up for the lack of gain in amplifiers. It was

also needed to overcome the stray fields due to poorly designed electric motors.

65. It is now generally accepted that today's amplifier must be built with sufficient gain to permit the use of a modern high-quality magnetic pickup.

66. Because of this, turntable motors are now engineered and built so that they will not interfere with the performance of a quality magnetic pickup.

67. Turntables designed to satisfy the factors outlined above are now available. Satisfactory multispeed turntables may now be had at a very modest cost.

68. A turntable should always be mounted so that the motor will be as far as possible from the reproducer head.

69. The turntable proper should be free of wobble.

70. When mounted, the turntable should be as level as possible.

71. A steel turntable should be solid throughout the area traversed by the stylus. That is, there should be no perforations of any kind throughout that area. As a rule, such perforations register in the loud speaker.

72. A good turntable should be free of rumble, both lateral and vertical.

73. A rumble not only registers in the speaker, but also increases record-wear.

74. Felt or rubber covering placed loosely on the turntable has a tendency to slip. This should be prevented if pitch variation is to be avoided.

Figure 1 shows the highest development in acoustic tone-arms, about 1926. Note the ball-bearing structure. The well in the base was filled with a viscous material which served the dual purpose of providing some damping at that end of the arm, and at the same time providing a fairly airtight junction between arm and horn. To cut down the transfer of stylus-generated exciter energy, suitable damping was applied at junction of reproducer and arm. In spite of all these precautions, however, the stiffness of the stylus was so great that some of the vibratory energy found its way to the arm.

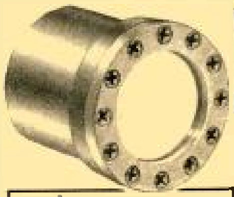
Figure 2 shows the first commercial electronic pickup, built by Audak about 1926. The tone-arm of this pickup moved in ball bearings. Note the reproducer-head pivoted at the front of the arm—a carry-over from the acoustic tone-arm. This was found to be highly undesirable—especially when the 33-1/3 r.p.m. discs came in with talking pictures.

Figure 3 shows a modern tone-arm.

In conclusion, it is hoped that the answers given in this article may prove of assistance. To those not versed in the art who may be contemplating the assembly of quality audio apparatus, the following suggestion is offered:

Assuming that, after inquiries and investigation, you have finally decided on the reproducer as the first step in building up the chain of audio components. Write to or call on the maker of the pickup, and ask him for his recommendations for a turntable and amplifier. It is natural for the maker of the pickup to wish his reproducer to perform with a good turntable and a good amplifier. For that reason, his recommendations may be depended upon. After that, you ask the maker of the amplifier what speaker he recommends. For the same reasons, the maker will want to recommend the speaker which will perform best with his amplifier .

The writer has seen this method of selecting audio apparatus work out satisfactorily in many cases. It is simple and costs nothing. Try it out the next time you have to assemble a system.



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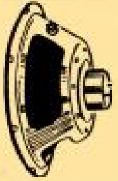

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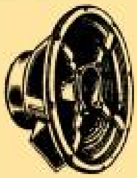

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D.C. HEATER SUPPLY

[from page 13]

proper value. The rectifier might be one 150-ma (or more) unit or, as shown, two parallel 75-ma units. A resistor of 50 to 100 ohms should be connected in the rectifier circuit to limit the peak current in the rectifier. The value of the resistor is not critical, but if parallel units are used separate and equal resistors (as shown at B in *Fig.* 1, R_3 and R_4) should be used since small differences in the resistances of the rectifier units may otherwise result in large unbalance in the currents flowing in them, and overload of one of the units.

Figure 1 (C) shows a full-wave bridge rectifier in a supply unit similar to that of (B). The rectifier should have a rating of 150 ma or more as a bridge unit—it can be made up from four 75-ma half-wave rectifiers.

The filters shown in *Fig.* 1 (B) and (C) will give high-voltage output and a well filtered supply. Omission of the input capacitor (C_1 or C_4) will lower the output voltage and reduce the size of the resistor R_5. For fixed installation, R_5 should be selected using, as with the plate series scheme, either a milliameter in the heater circuit or a voltmeter across the string. For an adjustable laboratory unit R_5 may well be a 500-ohm 20-watt power rheostat. The output capacitor (C_3 or C_6) effectively puts R_5 in the filter section, and R_6 is included to discharge the capacitors if the unit should be turned off with the heater string open.

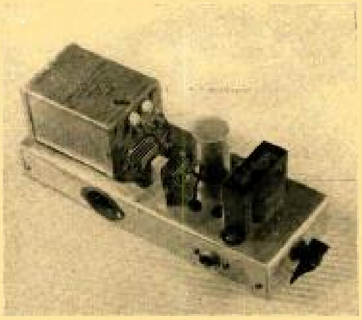

Fig. 2. Separate heater supply unit built by the author.

The low-voltage end of the heater string should be the most sensitive (lowest level) tube supplied, and the heater circuit should be grounded at the socket of this tube to discourage hum and/or noise from "riding in" on the heater supply.

The small selenium rectifier[1] and the high-capacitance low-voltage electro-

---

[1] *Miniature Selenium Rectifier Handbook*, Federal Telephone and Radio Corp., Clifton, N. J., contains a wealth of design and application data on these rectifiers.

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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.

★ Positions Open   ● Positions Wanted

★ **Project Engineer.** Permanent position for an electronic engineer of at least 5 years experience in radio broadcast and sound systems equipment, capable of independent development work in this field. Salary open. Send resume to Dr. A. K. Aster, The W. L. Maxson Corporation, 460 West 34th Street, New York 1, N. Y.

★ **Wanted:** Sylvania Electric has openings for engineers and physicists in all phases of electronic research, design, development, and application. These are permanent positions in a rapidly expanding program, and offer excellent growth possibilities. Several locations. For further information send resume or inquiry to D. W. Currier, Sylvania Electric Products, Inc., 1740 Broadway, New York 17, N. Y.

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lytic[2] also make practicable the provision of d.c. heater current from the low-voltage windings of a filament or combination power transformer. The basic schemes for this type of supply are shown in *Fig.* 1 (D), (E), and (F).

If two 12.6-volt windings or a center-tapped 25-volt winding are available on the transformer the full-wave rectifier shown at (D) may be used to supply several 12-volt heaters—two 6.3-volt windings may be similarly connected to supply a few 6-volt tubes. Each rectifier will carry only half of the d.c. output current in this arrangement, but the permissable voltage drop precludes the use of an effective network filter and the capacitor C_7 should be at least 200 µf. for each 150-ma load on such a 12-volt supply. C_7 in a 6-volt supply wired this way should be not less than 1000 µf for each 300 ma drawn.

The bridge connection shown at (E) may be used to supply 12-volt tubes from a 12.6-volt winding or from two 6.3-volt windings connected in series or 6-volt tubes from a single 6.3-volt winding. Filter capacitor requirements are the same as for the full-wave connection of (D), and each leg of the bridge rectifier will carry only one-half of the d.c. load.

Simplest Form

Simplest of the low-voltage d.c. supplies is that shown at (F)—a single half-wave rectifier with a single capacitor as the filter. In this circuit C_8 should have a minimum capacitance of at least 1000 µf. for each 150 ma of d.c. load at 12 volts, or 4000 µf for each 300 ma at 6 volts, and the ripple present in the heater circuit will, at best, be fairly heavy.[2]

It should be noted that filament windings used in any of the low voltage circuits (D), (E), and (F) need not be reserved for the d.c. supply alone—they may be feeding a.c. to other tubes as well, provided only that the added rectifier drain does not overload the windings. Grounding the negative heater lead to the lowest-level tube at the socket of that tube is still to be recommended with these low-voltage supplies—but if one of these circuits is added to an existing piece of equipment care must be taken to insure against short-circuiting the supply by grounding the d.c. output when the heater circuit is grounded elsewhere in the equipment.

Voltage to supply a bridge rectifier of the type shown at (E) may sometimes be contrived in a set where it is not obviously available. A transformer with a 6.3-volt filament winding and 5-volt rectifier winding, for example, may be made to serve by substituting a selenium or cathode type 6.3-volt rectifier for the 5-volt tube, and connecting the two windings in series to provide 11.3 volts to the bridge. Operating a low-level amplifier tube at slightly under its rated heater voltage will usually provide bet-

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[2] *Mallory Technical Manual,* P. R. Mallory and Co., Inc., Indianapolis, Indiana, contains a good non-technical summary of filter operation and design problems. A complete treatment will be found in Terman's *Radio Engineers Handbook,* McGraw-Hill Book Co., Inc., N. Y.

ter rather than poorer quality in that stage, and it will tend to reduce electrical and mocrophonic noises in the stage and to further reduce tube replacement variations.

PARTS LIST

C_1, C_2, C_3	150v, 80-µf electrolytic cond.
C_4, C_5, C_6	150v, 40-µf electrolytic cond.
Ch_1	8 henry, 150 ma choke
R_1, R_2, R_5, R_6	See text
R_3, R_4	50-ohm, 2-watt resistors
R_7	10-ohm, 2-watt resistor
Rect$_1$	Selenium rectifier (1–150 ma or, as shown, 2–75 ma)
Rect$_2$	" " (150 ma bridge, 75 ma each leg)
Rect$_3$	" " (rated ½ of d.c. load)
Rect$_4$	" " (bridge rated for full d.c. load, each leg rated for ½ of d.c. load)
Rect$_5$	" " (rated for full d.c. load)
C_7	25v elect. capacitor. For 6.3v, 1000 µf per 300 ma load For 12.6v, 200 µf per 150 ma load
C_8	25v elect. capacitor. For 6.3v, 4000 µf per 300 ma load For 12.6v, 1000 µf per 150 ma load

AUDIO PATENTS

[from page 3]

of the speaker, is fed to an electroacoustic horn transducer which acts just as a loudspeaker does in a conventional audio system—except that nobody can hear this one, including any microphones which may be in the vicinity. The system is diagrammed in *Fig.* 3.

Each person who is to hear the instructions, however, wears a tiny, ear-fitting devicing which might resemble a hearing-aid button and which can be made very inconspicuous, and which contains an ingenious demodulating system. There is a thin diaphragm made of piezo-electric material and this is moved by the supersonic air vibrations. So far, there would still be no demodulation, since displacement of the diaphragm would be even for both supersonic half-cycles. But across the piezo-electric diaphragm the inventor connects a small crystal rectifier. Now, as the diaphragm deforms in one direction due to the first half-cycle of supersonic air displacement, the voltage it produces across the rectifier due to piezo-electric effect pushes little current through the diode. But deformation in the other direction produces a piezo-electric voltage of opposite polarity and this causes current to flow readily through the rectifier. The comparatively heavy current flow loads the piezo-electric diaphragm and prevents it from deforming in full response to the air-pressure change. Thus the diaphragm is allowed to bend fully in one direction but not in the other. The nonlinearity does the same job as the second detector in a receiver and the demodulated carrier signal presented to the ear contains a fully intelligible audio signal.

You couldn't very well use a standard loudspeaker for this job and producing the piezo-electric receiver diaphragm might present problems. The system sounds extremely practical, however, and seems to have certain advantages over some of the r.f. systems now used for cueing in TV studios. The patent sheets contain circuit drawings and specifications for the ear and transmitter units.

CLASSIFIED

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

FOR SALE: Altec Lansing 604B speaker in 612A Utility Cabinet, $150 f.o.b. New York. Box CK-1, AUDIO ENGINEERING.

FOR SALE: Presto PT900R1 portable tape recording unit, approximately 200 hrs use; carefully handled by non-professional user; excellent condition. Best offer over $550. A. Ogawa, 49 Irving St., Cambridge 38, Mass.

FOR SALE: MAGNECORD amplifier, PT6J, in carrying case; includes 15-in./sec. equalizer Used one month, like-new condition $200, f.o.b. New York. Box CK-2, AUDIO ENGINEERING.

FOR SALE: PT900R1 Presto portable tape recorder used as demonstrator approx. 15–20 hrs., 50-ohm inputs, $675.00; Brook 10D 30-watt amplifier, $175.00; Altec 323B amplifier $95.00; Presto L2 playback amplifier-speaker unit, $197.00; two 6N recording cases, $20.00 each. All in good condition. Shipping charges COD. MASTERTONE RECORDING COMPANY, Box 1060, Des Moines, Iowa.

PRESTO OWNERS—ATTENTION!
6N and 8N overhead mechanism rebuilt for microgroove. 80 to 290 lines in 66 steps. Design proven 2 years in our studios. Write for particulars.

Trans-Radio Recordings Inc.,
683 Boylston Street,
Boston 16, Mass.

FOR SALE: Altec Lansing 605A speaker with dividing network, mounted in a Cameron Craft Blond Oak cabinet, $190. 2 Rek-O-Kut G2 standard, $75 each, including two Brush PL-20 arms. Entire lot for $325. James E. Palmer, 3095 36th Place, Sandia Base, Albuquerque, N. M.

SALESMAN WANTED: Sales experience essential, interested in Hi-Fi. Write stating qualifications and salary requirements, Box CK-3, AUDIO ENGINEERING.

LET ME IMPROVE your present amplifier to sound like a Williamson. Arthur Levine, 3405 Kossuth Ave., Bronx 67, N. Y. OL 2-8615, evenings.

TRANSCRIPTION TT OWNERS: Collection of original acetate recordings, including symphonies, Horowitz and Rubinstein piano works, Colman's "Tale of Two Cities," and others—over 50 total. Write for list. Box CK-4, AUDIO ENGINEERING

BRAND NEW Pickering diamond LP cartridge, original sealed box, only $32. Another used 30 hrs. $24. Pickering 190 arm, $18. Brush 60–12,000 headphones, $8. Brand new Barker speaker, $38. Brand new University speaker, $17. Plastic tape, two 7-in. reels, $4. BU 8-2057, H. Skalamera, 435 E. 74th St., New York 21, N. Y.

FOR SALE: PR-12 Federal disc recorder with radio and mike and BK-401 Brush magnetic tape recorder with Chinn conversion and 35 rolls tape. Best immediate offer. Apt. 152, 125 West 16th St., N.Y.C., CH 2-3226.

PROFESSIONAL DIRECTORY

Industry Notes--

Radio Club of America in midst of new membership drive. Questions concerning eligibility should be addressed to the Club at 11 W. 42nd St., New York City. . . . **Stancil-Hoffman Corporation,** Hollywood, has begun production of new Model S5 synchronous magnetic-film recording and reproducing equipment to meet needs of both TV and motion picture industries. . . . Seventh annual **Pacific Electronic Exhibit** scheduled for August 22–24 in San Francisco Civic Auditorium—event will coincide with western IRE convention. . . .

Lowell Metal Products Corporation, St. Louis, makers of acoustical equipment in audio field, announces name change to Lowell Manufacturing Company. . . . Eighteenth **National Radio Show,** British counterpart of Chicago Parts Show will take place August 28 to September 8 at Earls Court, London. . . . **Reeves Soundcraft Corporation,** New York, announces outright purchase of **Bergen Wire Rope Company,** Lodi, N. J. No changes anticipated in technical management group.

Curtiss-Wright Corporation negotiating for purchase of all assets of **Columbia Protektosite Company,** Inc., Carlstadt, N. J. In addition to continuing plastic manufacturing activities, Curtiss-Wright plans additional construction to house Electronics Division presently located at Caldwell, N. J. . . .**SMPTE** moving June 8 to larger headquarters in New York. New address will be 40 W. 40th St. . . . **Westinghouse Electric Corporation** planning huge plant near Bath, N. Y. for manufacture of electronic tubes. Plant will occupy 70-acre site, and employ 2000 persons. . . . **Walter Borten Company,** Peekskill, N. Y., startled trade with sample mailing of smallest twisted-wire-type brush ever produced commercially.

Industry People

Theodore Lindenberg appointed chief design engineer for Pickering & Company. Formerly with Fairchild, Lindenberg is past president of Audio Engineering Society. . . . **Wickham Harter,** Centralab sales manager, announces appointment of **Ted Lowell** as sales rep in Missouri and Illinois area. . . . Entire Audio industry shocked by passing of **William J. Nezerka,** v.p. of The Turner Company.

Joshua Sieger has resigned from Freed Radio Corporation to become independent technical consultant on radar, TV, and communications. . . . Appointment of **Richard H. Dorf,** Æ audio patents reviewer, as electronics project engineer announced by **Ira Kamen,** electronics director of Brach Manufacturing Division of General Bronze Corporation. . . .

W. E. Ditmars, president, Gray Manufacturing Company, announces promotion of **Harry W. Stewart** to commercial manager—formerly in sales promotion department. . . . **Rodney D. Chipp,** director of engineering for Du Mont TV network, slated to visit Europe. Will be accompanied by his wife who is v.p. and chief engineer of Newark Controls and president of the Society of Women Engineers, and who will be guest of the British Women's Engineering Society.

George O. Smith, writer of science fiction, appointed manager of components engineering for Emerson Radio and Phonograph Corporation, according to **R. T. Capodanno,** director of engineering. . . . **S. K. Burnell,** formerly of Westinghouse, has joined Burlingame Associates, manufacturers' representatives, as advertising director. . . . **Vinton Freedley Jr.,** is new account executive with NBC. . . . **Roy Neusch,** audio veteran and director of Harvey Radio Company sound department, back on the job after a bout with a bug. . . . **James Freeman,** media director of St. Georges & Keyes advertising agency, and associate **Richard K. Snively** building tape library of fine music with new Concertone.

HT

THE IDEA BEHIND THE WORDS HARTLEY-TURNER

3. *Attaining the near ideal.*

We have described the policy which begat the Hartley-Turner 215 speaker. The question arises "Have we produced something which really does appeal to high-fidelity listeners?" In many parts of America there are Hartley-Turner speakeasies formed by enthusiasts for our products. Here is a letter from one in Venezuela.

"It is thought you would like our report on the 215 speaker, three of which were received in perfect condition about two weeks ago. All were impressed by both the packaging and the fine workmanship. The speaker is a beautiful appearing job mechanically, the craftsmanship evident even to the lay eye.

"We set it up in line against my Klipschorn and three other well known models. About that time my wife was ready to throw all of us out.

"But there have been a number of evenings of listening—most of us skeptics thought it would be all over in one hearing—and the average reaction is one of being not quite able to believe it. But, more seriously, I think the group opinion boils down to this. It is a wonderful speaker. As you have said, it takes more "drive" than most. It is not as good as the Klipschorn (maybe we are over-conditioned to its sound, however). It is better than the second speaker, which lacks bass, having a sharp cut-off at 60 cps. Nothing else tested is in the same class.

"There have been other tests. We ran it as a bass woofer, feeding it from the low-half of a 400-cps crossover network, as a tweeter above 100 cps, and as a mid-range unit, 400-1000 cps. In each position we were impressed, but mostly in its high and low response. The answer to your low response is, of course, the available ⅜-in. movement without distortion. The highs—well, your cone is the first direct radiator I have encountered that approaches the crispness of a diaphragm-type speaker. Most of these are too crisp: I like the 215 there very much.

"As things stand now—and this is but a progress report—I still prefer my Klipschorn, but I never expected to find in one single unit the musical quality and range of the 215. As economics do not allow a Klipschorn in every room, the 215 will find one or several useful spots in my home as well as in some of the others' homes. And it will certainly be my recommendation to all of those who cannot afford a $600.00 unit."

* * *

Perhaps we cannot reasonably be expected to produce for $48.00 a better speaker than one costing $600.00, but if $48.00 is YOUR price level, the 215 will take you very far along the road to your ideal of undistorted sound reproduction.

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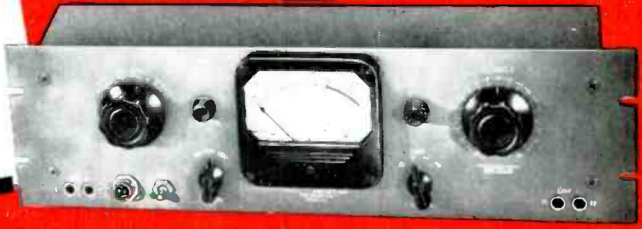

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