APRIL 1946

RADIO MAINTENANCE

P A SYSTEMS
A MIDGET AUDIO FREQUENCY OSCILLATOR
IF I WERE A SERVICEMAN
AN EQUALIZED AMPLIFIER FOR MAGNETIC PICKUPS

A BOLAND AND BOYCE PUBLICATION

BUSINESS GETTERS

With direct mail, you can multiply the prospects who come to your door—bring in new customers to keep your business and your profits steadily growing. Raytheon Bonded Electronic Technicians have a big story to tell—and have effective self-mailers to tell that story to the public.

These direct mail pieces are only a part of the broad program of *selling helps* made available *only* to Raytheon Bonded Electronic Technicians. Bonded service means better customer relations. For full details to qualify, see your Raytheon distributor today.

RAYTHEON
MANUFACTURING COMPANY

Excellence in Electronics

ANOTHER REASON WHY IT PAYS TO QUALIFY AS A RAYTHEON BONDED ELECTRONIC TECHNICIAN

RADIO RECEIVING TUBE DIVISION
NEWTON, MASS. • NEW YORK • CHICAGO

RADIO MAINTENANCE

INCLUDING

ELECTRONIC MAINTENANCE

Volume 2 APRIL 1946 Number 4

Contents

Departments

Radio Maintenance is published on the 15th of each month by Boland & Boyce, Inc., 460 Bloomfield Ave., Montclair, N. J. Subscription Rates: In U. S., Mexico, South and Central America, and U. S. possessions, $2.50 for 1 year, $4.00 for 2 years, single copies 25 cents; in Canada, $3.00 for 1 year, $5.00 for 2 years, single copies 30 cents; in British Empire, $3.50 for 1 year, $6.00 for 2 years, single copies 40 cents; all other foreign countries, $4.00 for 1 year.

Subscribers should allow at least two weeks for change of address.

Address All Mail to Our New Office
460 Bloomfield Avenue, Montclair, N. J.

"VOMAX"

Proof Converts A Doubter

We admit that our advertising of "VOMAX" describes the "one and only" . . . a v.t. multi-meter so new, so modern that it tops the list. Yet we know our each and every statement to be hard fact. Writes a converted "doubter":-

> " . . . I would not part with VOMAX for any money . . . I read with considerable interest your articles in July and August QST 'Taming the Vacuum Tube Voltmeter.' Your claims as to this instrument's ability as a Dynamic Signal Tracer were taken with a grain of salt, however, because I had considerable experience using the vacuum-tube voltmeter as a signal tracer and in most cases results were far from satisfactory. I have used the 'VOMAX' as a signal tracer on several jobs and am more than pleased with the results . . . I was also pleased to find the instrument so stable and free of zero shift. This stability was another of your advertising claims which I took with a grain of salt." (Signed) A satisfied serviceman, Clarence F. Hartzell, Altoona, Penna.

If that isn't proof to the hardest boiled technician, may we mention "VOMAX" order and **re**order by the U. S. Bureau of Standards? And as a clincher, you know that when your jobber is enthusiastic, it's because he has something of **real value** to you.

Say all eight New England stores of Hatry & Young; Radio-Wire-Television; Radio & Appliance Corp. of Nashville: "We and you, our customers, have waited a mighty long time for . . . 'VOMAX'—it's **more** than we expected."

Say Radio Equipment Distributors, Los Angeles; Burstein-Applebee, Kansas City; Walker-Jimieson, Chicago; Mac's Radio Supply, Southgate, Calif.; Arrow Electronics, New York; Rhode Island Distributing Co., Pawtucket; Lew Bonn Co., Minneapolis and St. Paul; Wholesale Radio Laboratories, Council Bluffs; Terminal Radio, New York; Newark Electric of Chicago and New York; Lukko Sales, Chicago; "In our critical opinion these features establish 'VOMAX' as standard of comparison."

To tie the knot of acceptance and superiority even tighter, Bendix is now recommending "VOMAX" to all BENDIX RADIO distributors **and** dealers to insure top-flight service.

Your favorite jobber can probably squeeze your "VOMAX" out of his monthly allotment—if you act fast . . . while it's still only $59.85 net.

Send postcard for complete specifications of "VOMAX," new 904 Capacitance-Resistance Bridge, 905 "SPARX" and other new, post-war, SILVER measurement and communication products. See them at the Chicago Trade Show, May 13 thru 16.

OVER 35 YEARS OF RADIO ENGINEERING ACHIEVEMENT

McMurdo Silver Company

1240 MAIN STREET, HARTFORD 3, CONNECTICUT

PA Systems

Public Address is a field of great potential profit to the serviceman. This is the first of a series of articles designed to increase your profit from this source.

by C. G. McProud

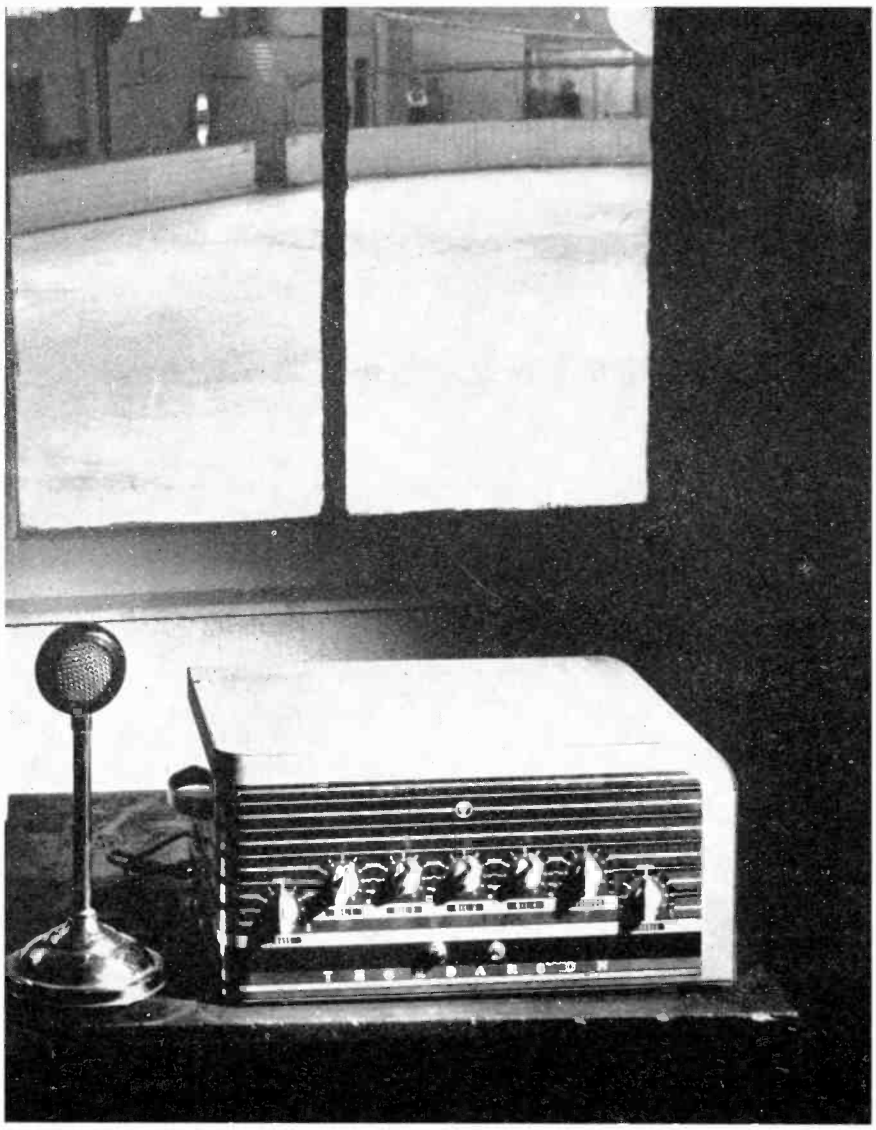
A VERY PROFITABLE ENTERPRISE available to the radio serviceman is the sale, installation, and servicing of public address systems. In spite of the obvious magnitude of this business, it appears that there is relatively little information available to develop the potentialities inherent in every radio serviceman's locality. There are so many applications for PA systems and so many varied types of equipment that this series is offered to aid the serviceman in developing another very profitable sideline.

A compilation of the primary considerations which influence the choice of equipment makes a logical beginning, for, the size of the installation, the use to which it is to be put, and the quality desired are all important factors.

General Considerations

In selecting equipment for any PA system, the primary element which must be considered is that of the coverage required. Coverage may be defined as the area or the size of the audience which must receive adequate sound volume to provide satisfactory hearing of the intelligence being transmitted. In this regard, cognizance must be taken of the location at which the system is to be used, the size and shape of the area to be covered, the size of the audience, the noise level, and the type of reproduction for which the equipment is required. The type of system used for a large outdoor audience at a race track or baseball field where there is a large amount of audience noise is entirely different from that required for speech reinforcement in an auditorium, or for the reproduction of background dinner music in a restaurant. However, the systems to suit these various requirements may be classified into groups as shown in Chart I.

An inspection of this chart gives us a great deal of information about PA systems quickly. In the first place it will call our attention to the fact there are very few applications where a mobile or portable system is required for indoor use. Furthermore, it tells us that the quality of reproduction required from portable systems, with the exception of those for outdoor dance applications, is such that they must provide good intelligibility over the voice range. In this compilation, the term "mobile" indicates systems which are self-powered, that is from batteries or a portable gas-driven generator. It must also be noted that in every case, outdoor application of portable equipment entails adequate coverage over a high noise level. With the possible exception of police use for direction of traffic, most of the uses for mobile installations are for large outdoor gatherings. There are some exceptions to this, of course, as to any of the other factors in the chart, and it must be remembered that the chart does not endeavor to present all of the possible uses of PA systems, but rather to point out the more frequent ones.



Courtesy Terminal Radio Co.

Proceeding to the permanent installations, we see that the outdoor uses entail noise levels from medium to very high, and cover audiences ranging from 100 to 50,000 people. Intelligibility is the primary factor entering into the outdoor installations. Indoor applications usually cover smaller groups of people, with on the average, a much lower noise level, but the requirements lean towards the reproduction of music, with rather higher quality than is generally provided in outdoor installations.

Having considered the requirements of equipment for various types of installations, let us now consider how these requirements may be fulfilled. The physical and electrical characteristics of PA systems which must be determined in the installation design are:

- Power requirements
- Fidelity
- Gain
- Controls
- Input sources
- Loudspeakers
- Transmission lines
- Co-ordination of equipment

The basic factors controlling the determination of these characteristics must be carefully considered before the elements of a good PA system can be specified, and the governing conditions must be studied so that the entire installation may be properly co-ordinated to do the job required of it, and thus be a credit to your ability in the assembly and installation of equipment.

First, then, we will discuss these factors and their influence upon the design of a PA system. For the time being we will not consider methods of fulfilling the requirements dictated by the various elements entering into the original design.

CHART I—PA SYSTEM CHARACTERISTICS

MOBILE INSTALLATIONS

Location	Typical Use	Audience	Noise Level	Type of Reproduction	Important Features
Outdoor	Group Gathering	1,000 to 25,000	High	Voice	Adequate Coverage and Intelligibility
	Fairs	500 to 5,000	High	Voice	
	Picnics	100 to 1,000	High	Voice	
	Dances	100 to 500	High	Music	Good Bass Response

PERMANENT INSTALLATIONS

Location	Typical Use	Audience	Noise Level	Type of Reproduction	Important Features
Outdoor	Baseball Field	1,000 to 50,000	High	Voice	Intelligibility
	Open air Concerts	500 to 5,000	Medium	Music	High Quality
	Airports	Up to 1,000	Very High	Voice	Intelligibility
Indoor	Concert Hall	500 to 5,000	Low	Music	Highest Quality
	Theatre	500 to 3,000	Medium	Voice, music	Intelligibility
	Dance Hall	200 to 2,000	High	Music	Good Bass
	Restaurant	50 to 300	Medium	Music	"Mellow" quality
	Cabaret	50 to 300	Medium	Voice, music	Intelligibility

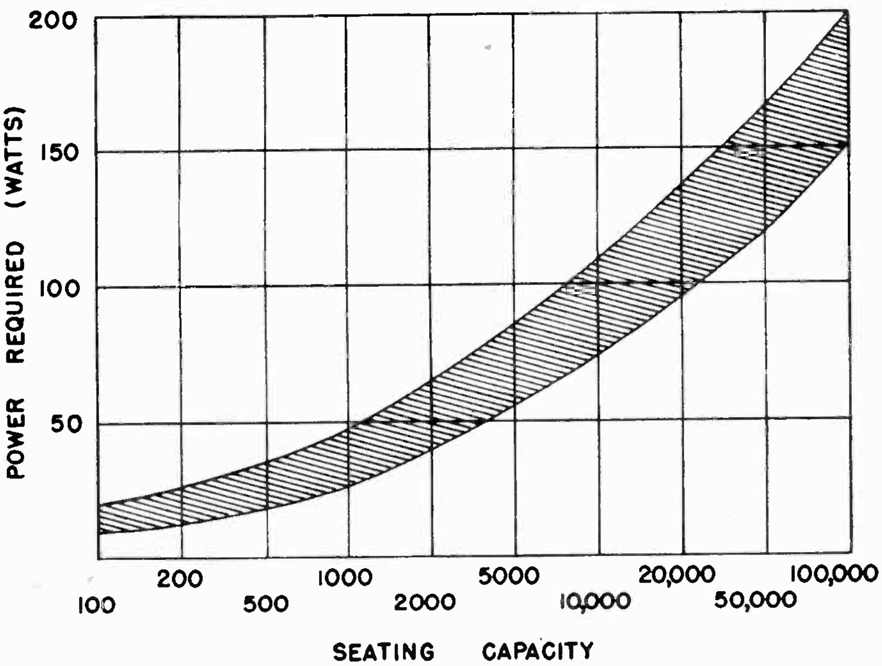


Fig. 1 Curve showing approximate power required for adequate coverage of audiences of various sizes. Upper limits of shaded area should be used for locations with high noise level, or where maximum fidelity of music reproduction is desired.

Power Requirements

In determining the type of system to be installed, it is probable that the most important single consideration is the amount of power necessary. The power requirement indicates that the system must be selected to supply the required sound volume, in the most economical fashion. It would be folly to install a 50-watt system to furnish a background for a restaurant seating thirty people, just as it would be folly to install a fine 15-watt portable system to announce a baseball game.

The absolute unit of power measurement as applied to sound is the acoustic watt, which, although of interest academically, is of little relative value to the designer of a PA system installation. While it would not be sufficient to say that 50 watts of audio power is required for a certain installation unless the efficiency of the loudspeakers is specified, it may be assumed for practical purposes that the speaker efficiency in a good PA system is approximately 25 per cent; this value, while higher than that of the average radio speaker, is necessary to make the average installation economical. The use of less efficient speakers demands more power from the amplifiers, and is, in the long run, unprofitable.

Inasmuch as we may assume a speaker efficiency of 25 per cent, we can now give the power requirement in watts of audio power. Experience has shown that from 150 to 200 watts of audio power is necessary to cover adequately a large outdoor gathering, such as a baseball field or concert stadium. This presupposes an audience of from 5000 to 50,000 people distributed in the space occupied by the average grandstand.

Standard practice for motion picture theatres calls for the installation of a 50-watt amplifier for medium-sized houses (those seating from 1000 to 3000 people) while a 30-watt amplifier serves for theatres seating less than 1000 people. It is also known from experience that 10 watts is sufficient for systems used in general applications such as dances, restau-

→ To Next Page

PA SYSTEMS

→ From Preceding Page

rants, picnics and so on, with audiences of less than 100 people. Figure 1 portrays this information in the form of a curve. The shaded area indicates the approximate limits within which the power requirement falls, the actual power determination varying this slightly because of several other considerations. The upper limit of the shaded area of the curve in Fig. 1 should be chosen where the reproduction is primarily of music and where the highest quality is required, and for locations which are troubled with a high noise level. Where a sound system is used predominately for speech reinforcement, and the bulk of the power can be concentrated into the frequency range of from 150 to 4000 cps, the lower limit of the shaded area of the curve should be selected. This will also apply in such installations as churches, hotel rooms, and other locations which have an extremely low noise level.

In large railroad stations, or in installations where several parts of a building are to be served, it is necessary to total the power requirements of all of the locations which are to be equipped with loudspeakers and then arrange the distribution of power to the various loudspeakers in accordance with the demands of coverage and directivity placed upon each speaker.

In planning an installation such as would be required for a large hotel, it is interesting to note that enough power must be provided so that every speaker in the hotel may be in use at once. The term "use factor" is employed to indicate the probability of use of the various outlets, which determines the total load placed upon the system at any one time. The use factor multiplied by the total power necessary for all the speakers indicates the amount of power necessary for any one of several channels. If two channels are provided, less power is required for each channel, the use factor being 90 per cent. This means that if 50 watts of power is necessary to supply all the rooms in a hotel on one channel, each of the two channels will require only 45 watts. The use factor for three channels is 75 per cent, and for four channels, 60 per cent.

Fidelity

The term "fidelity" includes a number of considerations. By definition, fidelity is the degree with which a system accurately reproduces at its output the essential characteristics of the signal that is impressed on its input. It means much more than frequency response of either the amplifiers, microphones or speakers. Frequency response is a rating which indicates the range over which a system handles all frequencies uniformly. Thus, a system may be said to have flat response between 100 and 6000 cps, meaning that a curve of output plotted against frequency is "flat" on the graph from 100 to 6000 cps.

"Fidelity" also includes the distortion characteristic. For systems of the highest quality, harmonic distortion—the presence of frequencies in the output which were not in the input but are generated in the system itself, and which are harmonically related to the input frequencies—must be kept below one per cent at the normal operating level. This requirement applies to those installations in theatres and concert halls where music is a large portion of the program content. For speech reinforcement use, distortions up to five per cent are not too objectionable, provided the upper frequency limit of reproduction is held down to about 5000 cps. Harmonic distortion becomes increasingly unpleasant to the ear as the upper frequency limit is raised. This brings us to definition of speech reinforcement.

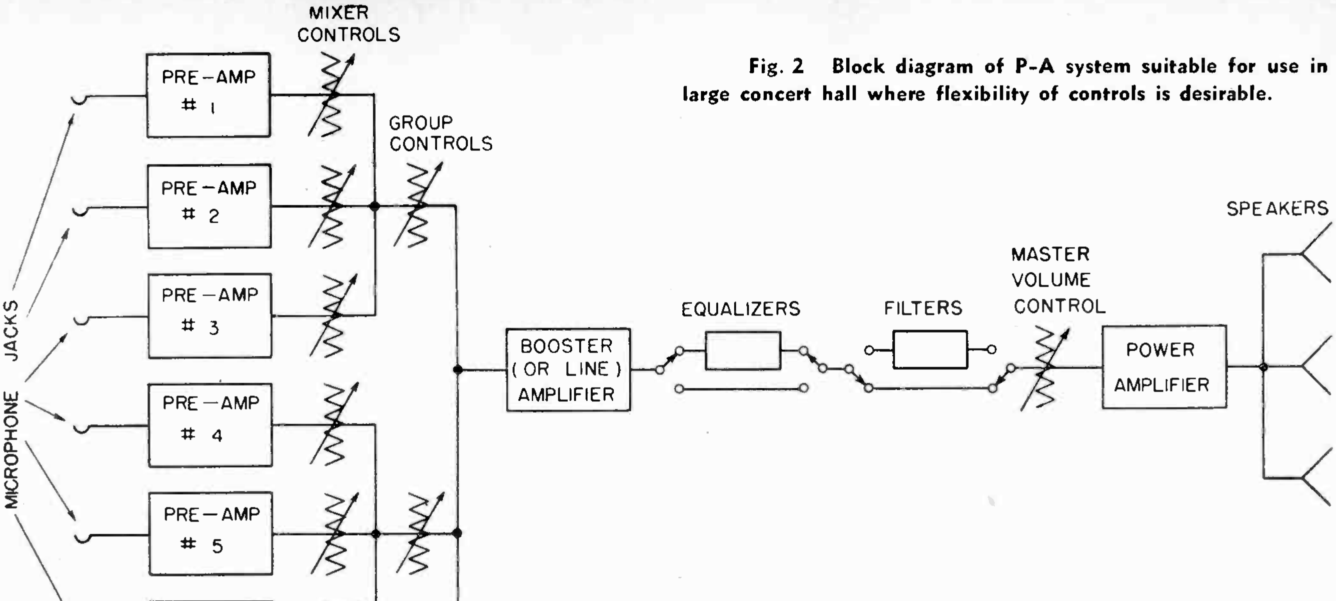
There are two distinct classes of use to which PA systems may be put. One is as a means of announcing at a distance, such as train calling in a railroad station; the other is for "reinforcement" which implies the use of the system to aid the original source of the sound to reach the listener. A sound reinforcement system, whether used for voice or for music, should be cleverly designed and installed so that the listener is not conscious of the use of artificial means to aid his hearing.

Intermodulation distortion is another disturbing element which enters into the picture. Poor amplifier design will permit an increase in intermodulation to such an extent that the reproduced sound is extremely unpleasant. Bad cases of intermodulation will manifest themselves in the break-up of the higher frequencies caused by simultaneous low frequencies from the performing source. This condition often becomes especially bad when a vocalist is singing accompanied by a small orchestra with a heavy bass viol arrangement. The condition is frequently encountered in night club installations. The design and assembly of a high quality system necessitates a careful selection of components that are free of harmonic and intermodulation distortion.

The frequency response of a public address system is also an important consideration. For systems used predominantly for music, the range of the equipment should extend from 60 to 10,000 cps, although the trend is toward a still wider range of response. It might be well to provide a range of from 35 to 15,000 cps for the very finest *direct* pickups. This means that if the original source of the music to be reinforced is coming direct from an orchestra or singer, such a range may be advisable. If, however, the source of sound is from records, or even from electrical transcriptions (which are generally of higher quality than commercial phonograph records) there is very little to be gained from such a wide range of reproduction, because the upper limit of frequencies recorded is not that high and because of the presence of background noise, which becomes more noticeable as the upper frequency limit is raised. In such cases, a frequency response from 80 to 8000 cps should be quite adequate.

It will be noted that both the upper and lower limits are specified in mentioning these ranges. It has been conclusively determined by many subjective tests with musicians and sound engineers as listeners, that the upper and lower frequency limits are related, and that when the upper limit is raised, the lower limit should be lowered. It is a fairly well established fact that the product of the upper and lower frequency limits should be 640,000. This means that if the upper limit is 10,000 cps, the lower limit should be 640,000/10,000 or 64 cps. When the upper limit is 5000 cps, the lower limit should be 128 cps. The center point of the accepted sound range is seen to be 800 cps. For best results, the range should be the same number of octaves above 800 cps as it is below, an octave being the difference between two tones whose frequencies are related by a factor or two. For example, one octave below 800 cps is 800/2, or 400 cps; an octave above 800 cps is 800X2, or 1600 cps.

Many sound reinforcement installations are used only for speech. For-



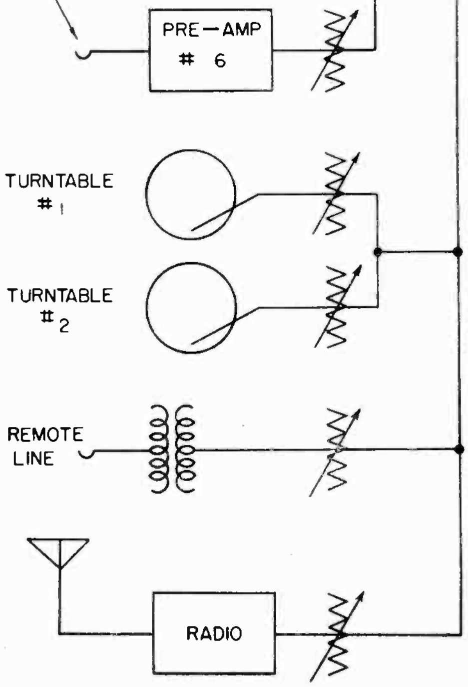


Fig. 2 Block diagram of P-A system suitable for use in large concert hall where flexibility of controls is desirable.

tunately, this applies particularly to the very large systems, such as those at baseball fields and race tracks. It is fortunate because with the majority of power concentrated into a reduced frequency spectrum, greater coverage can be had with less power, and less care need be taken in eliminating distortion. Output transformers capable of full power output at low frequencies are relatively expensive, and much better filtering is necessary in amplifiers and speakers capable of reproducing 60 cps very efficiently. Limiting the upper frequency range to 5000 cps removes a large portion of the spectrum in which distortion is most noticeable. The use of directional baffles, or horns designed specifically to cover only the audience, also improves the efficiency of the system.

Gain

The total gain necessary for a satisfactory PA system must also be taken into consideration. Gain is measured in decibels, or db, which are units employed in sound measurements. The decible is an expression of a ratio of power or a ratio of voltage. Thus, knowing both the input voltage, E_i, and the output voltage, E_o, of a system, the gain may be determined by the expression

Gain (in db) $= 20 \log E_o/E_i$

If the input *power*, P_i, and the output *power*, P_o, are known, the gain is calculated as follows:

Gain (in db) $= 10 \log P_o/P_i$.

Db may be added or subtracted; an amplifier adds a certain number of db, and an attenuator subtracts a certain number of db. An amplifier with a gain of 20 db is used with a power amplifier having a gain of 60 db, so the gain of the two amplifiers in cascade is $20+60=80$ db.

As a measurement of volume level, the term "dbm" is used. It means that the specified level, or sound volume of a *constant tone*, is a specified number of db above a reference point of .001 watts or 1 milliwatt. One other abbreviation that may be encountered is "vu", or volume unit, which specifies the type of meter which was used to measure the level of the signal, and furthermore means that the measurement was made on average program material, rather than on a constant tone. Vu and dbm both refer to a zero level of .001 watts, and differ only in type of sound being measured. In order to determine the total gain required by a PA system, it is necessary to know the output level required, and the input level from the sound sources. If an output power of 60 watts is required, which corresponds to +48 vu, and the microphone input level is —75 vu, it will require the use of 48+75, or 123 db of gain in the amplifier.

Volume Range

While volume range is not an especially important consideration, it is well to keep it in mind. The term volume range is used to indicate the range, in db, between the maximum output power of an amplifier and the noise level of the entire system. Volume range is, therefore, an expression of the useful range over which a system will work, for it is obvious that the output level cannot exceed the maximum power capability of the equipment, and it is also obvious that the sound output lower than the noise level is masked by the noise.

For satisfactory reproduction of music, a volume range of 65 to 70 db is considered desirable. This is apt to introduce some difficulty with the hum filtering. Take for example an output of 60 watts corresponding to a level of +48 vu. 65 db below +48 bring us to a level of —18 vu. For satisfactory results the hum and noise should be 10 db below the minimum sound to be reproduced, which means that the hum level must be below —28 vu. This is quite a strict requirement for large systems. Such wide volume ranges will not be encountered in outdoor systems, but are limited to concert halls, theatres, night clubs, etc. Good indoor reproduction of speech requires a range of

→ **To Next Page**

PA SYSTEMS

→ From Preceding Page

50 to 60 db, whereas outdoors a range of 30 db should be sufficient.

Controls

The type and number of controls required will vary considerably. In the large theatre or concert hall installations, as many as ten microphone inputs may be necessary, with additional ones for turntables, remote lines, and perhaps a high quality radio receiver.

Separate microphone controls are generally known as "mixers," whereas others known as "group" controls will vary the volume of several input sources simultaneously. Practically any good PA system will also employ a "master" control, which is used to vary the output of *all* input sources, and consequently the entire sound output from the system, simultaneously.

Four microphone controls should suffice for any type of large outdoor installation, with possibly one additional control for a turntable.

In high quality installations, the use of tone controls may often be advisable. In particular, some method of equalization should be available for voice pick-up, to eliminate the lower frequencies which detract from intelligibility. A range of 10 db up and down from flat response at 100 and 7000 cps gives adequate control. In addition, high-pass and low-pass filters are very useful in removing unwanted sounds from the reproduction. An 80-cps high pass filter will remove most of the rumble from dancing feet, crowd noises, or street sounds where they are picked up by the microphone. A 7000-cps low-pass filter is often an advantage in reducing distortion from various sources, and in eliminating noise from record reproduction. Additional filters may be required in some systems, with low-frequency cut-off at 125 to 150 cps, and high-frequency cut-off as low as 4000 cps. The incorporation of these elements into a large system will make it sufficiently flexible for any sound source.

Just a word about microphone controls. The simple and inexpensive systems generally use high impedance potentiometers in the grid circuit of the second tube in the amplifier. For large installations, these are not adequate, mainly because their use limits the design of the equipment by requiring the controls to be located right on the amplifier itself. In such cases, the mixer controls should be of low impedance, and should follow one stage of pre-amplification. The range of each mixer control should be fairly linear in db loss from minimum to about 50 db, then taper rapidly to infinity. In large installations, it should be possible to group several mixer controls so that their combined output feeds into a "group" control, in addition to the master volume control. Two or three of these group controls should be provided.

Figure 2 shows a block diagram of a system of this type, complete with pre-amplifiers, mixer controls, group controls, booster amplifier, master volume control, and power amplifier.

Thus far, little has been said about small systems. In these, it is common practice to provide controls for three, four, or five sources, which may be microphones, turntables, remote lines, or radio receivers. Filters are rarely available, although both low- and high-frequency tone controls are generally provided.

Input Sources

The input sources for public address systems are generally limited to microphones, turntables, remote lines, and radio receivers, depending upon the use to which the system is to be put.

There are many types of microphones available, each of which possesses its own list of advantages and limitations. The source of sound must be considered before any selection of microphone type can be made, and furthermore, the placement of the microphones must be known. For pick-up from a singer or speaker, where the source can be close to the microphone, it is advisable to use a given type, whereas pick-up from a full orchestra requires the use of another type. A list of the various types follows, with the characteristics of each:

Velocity, or ribbon microphones. These have excellent frequency response, in the better grades, and have directional characteristics which makes them advantageous when simultaneous use is made of several microphones. One such arrangement is shown in Fig. 3, where A represents a microphone for the solo singer, B is a microphone for the chorus, and C is a pick-up for the orchestra. The ribbon microphone has a pattern as shown in Fig. 4, which indicates that there is very little pick-up from the

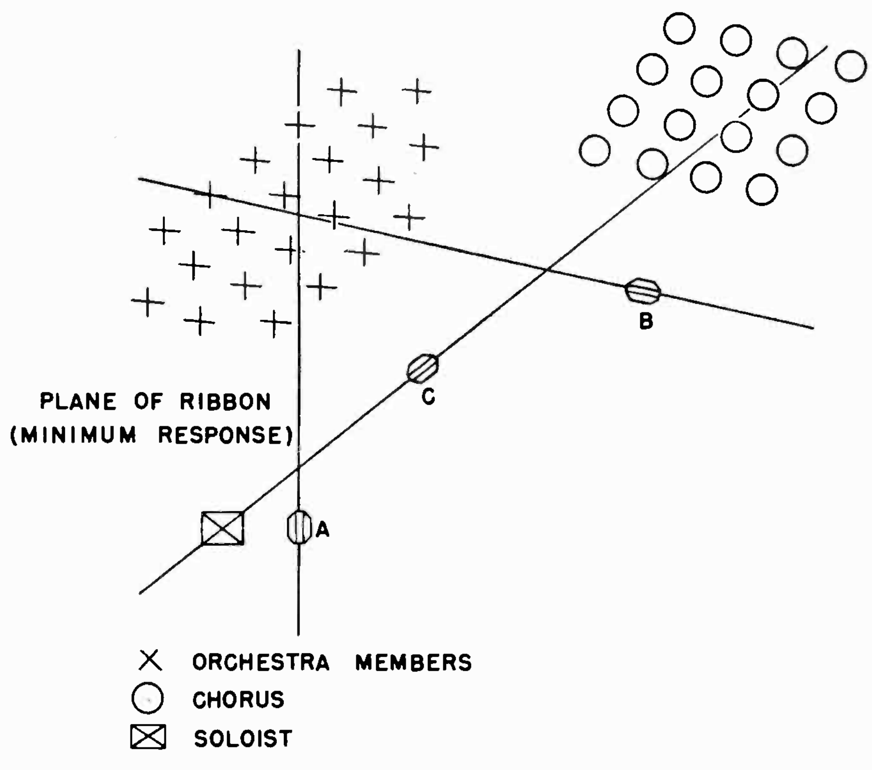


Fig. 3 Possible placement of microphones for chorus, singer, and orchestra to reduce pick-up of any section on other microphones.

sides. The ribbon microphone is not completely suitable for close talking, without the provision for equalization, as it has a rising low-frequency output when used near a sound source. It works best at distances greater than two feet.

The dynamic microphone is small and rugged, and is an excellent all around performer. It is exceptionally well suited for voice pick-up and works satisfactorily for close talking. The directional pattern is essentially a circle, although there is some slight discrimination against sounds from the rear. Both the ribbon and dynamic microphones are normally low-impedance devices, the dynamic requiring no transformer and having an output impedance of 30 to 50 ohms; the ribbon has an impedance of about one quarter of an ohm for the ribbon itself, with a transformer in this case providing output impedances of 30, 50, 200, or grid, depending upon the manufacturer. In some cases, several of these impedances are available, selection being made by a built-in switch. Dynamic microphones are also available with transformers built-in, to provide high impedances.

Crystal microphones have a natural high impedance, and are ideal for connection directly into grid circuits. Being a capacity generator, the crystal microphone is not subject to change in frequency response due to change in cable, although an increase in cable length will decrease the output level. Other types of high impedance microphones suffer from loss of highs when cable length is increased.

Uni-directional microphones are composed of two different types of elements combined together in the same case, each having its own directional pattern. Fig. 5 shows how the patterns of the ribbon and the dynamic can be combined to give a minimum of pick-up from the rear. This type of pattern is advantageous when bad feedback conditions are encountered, or when audience noise is objectionable. Such a microphone may be composed of a ribbon and a dynamic unit, or of various other combinations, being available also with a crystal unit. Some are available with patterns of ribbon, dynamic, or uni-directional type, selectable at will by a switch incorporated in the unit.

The output level of microphones varies over a rather large range. The highest output from good quality microphones is around —45 db, and varies down to about —75 db for the lowest outputs. In general, the higher the quality of the microphone, the lower the output.

Pick-up from turntables is accomplished by means of crystal, dynamic, and magnetic devices, with their several characteristics. The crystal pick-up is the most common, having a high output level, and being fairly easy to equalize. For high quality installations, the dynamic type is most often employed, although there are many high grade crystal units in use. These require, in most cases, a pre-amplifier near the turntable, and thus are disadvantageous where the controls must be located at a distance from the turntables.

Pick-up from remote lines should follow broadcast practice. Lines for this service are generally installed by the telephone company, and are equalized in accordance with the requirements. Such lines should be isolated from the equipment by suitable transformers, to avoid multiple grounding which might otherwise occur.

When radio pick-up is required, the receiver should be of high quality, and should be designed to feed the public address system at low level, with a very low hum content. When properly designed, such an installation will present no problems.

Loudspeakers

The problem of loudspeakers is a very important one, and deserves detailed consideration. The requirements vary over a wide range, both with respect to quality of reproduction and power handling capability. Other factors are efficiency, directionality, and placement.

For small and medium power systems used in speech reinforcement, a directional baffle is generally resorted to. This type of reproducer can be obtained as a re-entrant horn using a cone loudspeaker, as a trumpet, or as a re-entrant horn using driver units designed for this purpose. The horn unit is available in permanent magnet form, just as is the cone type, and the former is apt to be the more efficient. For applications similar to those used in the guest room of a hotel, the cone type of speaker is used, generally mounted in an ornamental wooden cabinet.

Large installations such as baseball fields, generally demand the use of directional horns, which limit the sound to the area to be covered, thus cutting down lost energy. This is done in the interest of economy, and is particularly important from this standout.

High quality reproduction for large halls is best obtained by the use of a

→ To Page 26

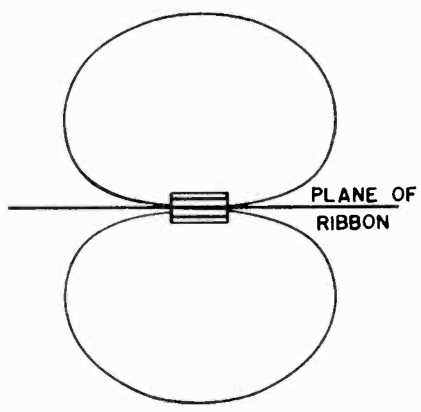


Fig. 4 Directivity curves for velocity or ribbon microphones.

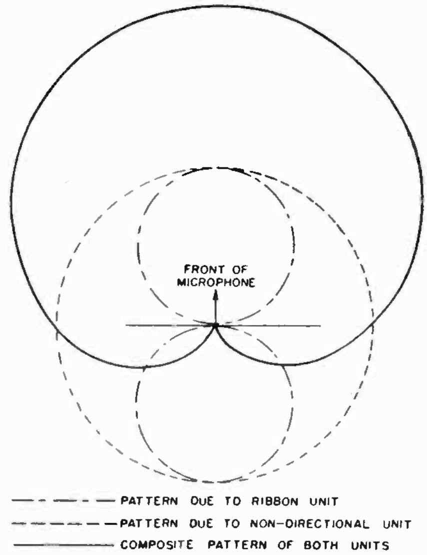
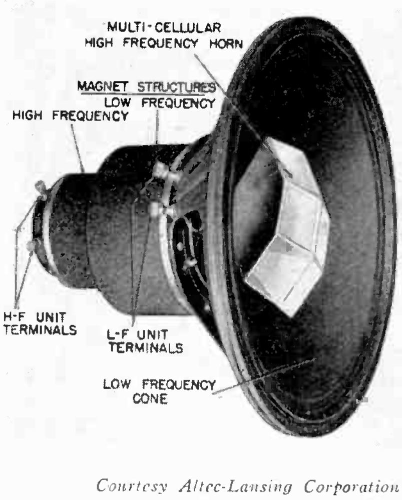


Fig. 5 Addition and subtraction of the sound energy received by the two sections of the uni-directional microphone produce the overall pattern known as a "cardioid."



Courtesy Altec-Lansing Corporation

Fig. 6 Duplex loudspeaker which provides a horn unit for high frequencies and a large cone unit for low frequencies. The crossover point is 2,000 cps.

A Midget Audio Frequency Oscillator

by Rex Gilbert

A little instrument that does a big job

OCCASIONALLY in the many and varied operations that constitute radio servicing, a need is felt for an audio frequency oscillator. With this in view, and with a number of factors entering into the requirements, the small and easily portable instrument described here was developed. It is extremely compact, and completely self-contained, but it is able to perform many of the duties of a larger and more costly instrument.

The factors comprising the requirements of the design were: Size—no larger than a "personal radio"; Power—self-contained batteries for both "A" and "B" supply; Frequency range—25 cps to 25,000 cps; Output impedance—500 ohms; Output voltage —.01 volts maximum.

Simplicity dictated the use of a resistance-capacity oscillator circuit, rather than the beat-frequency principle, which generally requires at least four tubes. This design makes possible the fulfillment of all the requirements with only two tubes, a 1T4 and a 3S4.

Without entering into any theoretical discussion, the circuit is first described. Following that, the mechanical aspects of the oscillator are described, and finally the method of calibrating it.

The basic resistance-capacity oscillator consists of a Wien bridge in the feedback circuit of a two stage amplifier, as shown in Fig. 1. At the null frequency of the bridge, there is sufficient positive feedback to cause oscillation. There is also considerable negative feedback which acts as a stabilizing element, and improves the waveform.

To make such an oscillator tunable, it is necessary to vary the null frequency of the bridge. In some oscillators of this type, this tuning is done by varying the capacity; in others, by varying the resistance. With variable capacity tuning, a 4-gang broadcast tuning condenser is generally used, which is nearly as large as this entire oscillator. By varying the resistance, the tuning device can be considerably smaller, and the scale is spread over about 270 deg. of the dial, which is an advantage. Following the oscillator proper, an output control is used, and following this, a three-stage attenuator which reduces the voltage in 20-db steps. Assuming a maximum output voltage of .01 volts on the X100 step, .001 volts will be available on the X10 step, and a minimum of .0001 volts on the last step, with the output control at maximum. Reducing the setting of the output control reduces the voltage still further to about .00001, or 10 microvolts. This makes the instrument suitable for testing high-gain amplifiers without further attenuators.

Construction

For the housing of this oscillator, a small personal portable cabinet was used, there being a variety of these available. By placing a dial plate over the opening intended for the speaker, a suitable mounting was provided for the tuning potentiometer. There is nothing very difficult about the construction, except the possible precaution about taking normal care in wiring to avoid proximity of plate and grid circuits of the same tube. The filament circuits of both of the tubes are above ground, and must be operated from separate batteries. This makes it necessary to use three 1½-volt unit cells. If a 1S4 is in the "junk box" it can be used just as easily by paralleling the two cells. Figure 2 shows the complete circuit, using the 3S4.

The three-watt, 110-volt lamp in the filament return circuit of the 1T4 requires a socket for mounting it. This is a dial-lamp socket for a candelabra base.

C-1 approximates the wiring capacity of the switch and the grid-circuit of the tube to ground. The pairs of condensers C-2 and C-5, C-3 and C-6, C-4 and C-7, should be matched as closely as possible. If accurate dial calibration is required, some experimentation will undoubtedly be required with the first and second mentioned pairs. Start with the C-4 and C-7 pair, and get them as well matched as possible, either by trying different pairs, or by shunting one or the other with small mica units. The optimum

adjustment of these capacities will be indicated by the highest output. After getting C-4 and C-7 properly matched, proceed with the calibration as outlined below. After completing the calibration, it is then advisable to make the adjustments for the second pair of condensers. Instructions for this are given here as the operation falls under construction.

With the first pair of condensers properly adjusted for maximum output, and the calibration completed, the next step is to adjust the second pair of condensers. Following the same procedure as for the first pair, adjust the two condensers C-3 and C-6 for maximum output, by adding small condensers across them, as required, or by trying different pairs of condensers. When the maximum output is obtained, signifying proper adjustment, check the 250 cps signal on the x1 step of the frequency switch with the 250 cps signal (indicated by the dial setting of 25) on the x10 step of the frequency switch. These two tones should be the same. If possible, another oscillator should be used with this adjustment, with one signal on the horizontal plates of an oscillograph and the other on the vertical plates. At identical frequencies on both, the pattern will be a circle, (or an ellipse or a straight line, depending upon the phase difference between the two signals), and will appear to stand still. When the x1 and x10 positions of the frequency switch are made to agree at one point, they will agree through the scale.

The same steps are followed in making the x100 position agree with the x10 position, using 2500 cps as the checking frequency. None of these operations is difficult, nor does it require any special equipment, other than that used for the calibration. Even if no equipment is available for the calibration, the oscillator will be useful in checking cabinet resonance, speaker rattle, and other factors requiring a source of variable audio frequency. However, if it is possible to make a complete calibration, the uses of the instrument are definitely increased.

Calibration

To calibrate the instrument properly, an oscillograph is practically a necessity. Without entering into a discussion of all the fundamental relations between frequencies, and their resultant wave forms on the screen of a C-R tube, it is possible to give instructions for the calibration of this type of oscillator which can be followed by anyone familiar with the mechanics of operating the controls of the oscillograph itself. Since all three scales of the oscillator are known to follow each other correctly, it is only necessary to calibrate one of the scales. The easiest one to calibrate is the lowest frequency scale, and with no additional oscillator to calibrate against, it becomes almost imperative. This can be done quite accurately with no standard except the 60-cps frequency of your power lines.

Having only an oscillograph and the line frequency, the following method is used. Connect a source of A-C voltage, such as the 6.3-volt secondary of a filament transformer, to the horizontal input of the oscillograph, and connect the output of the A-F oscillator to the vertical input. Remove the dial and knob from the shaft of the dual potentiometer, and attach to the panel a scale calibrated from 0 to 100 and covering the full range of rotation of the knob. Lacking this, use a protractor scale calibrated in 360 deg. Place a knob with

→ To Next Page

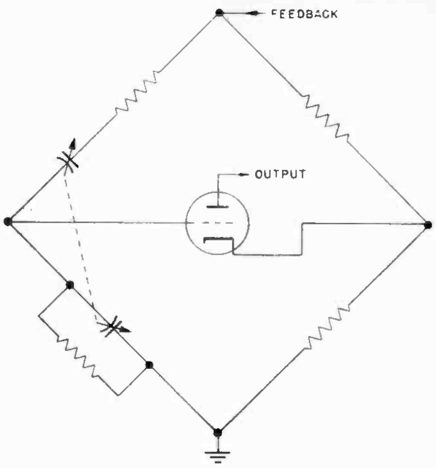


Fig. 1 Simplified schematic of bridge circuit for resistance-capacity oscillator.

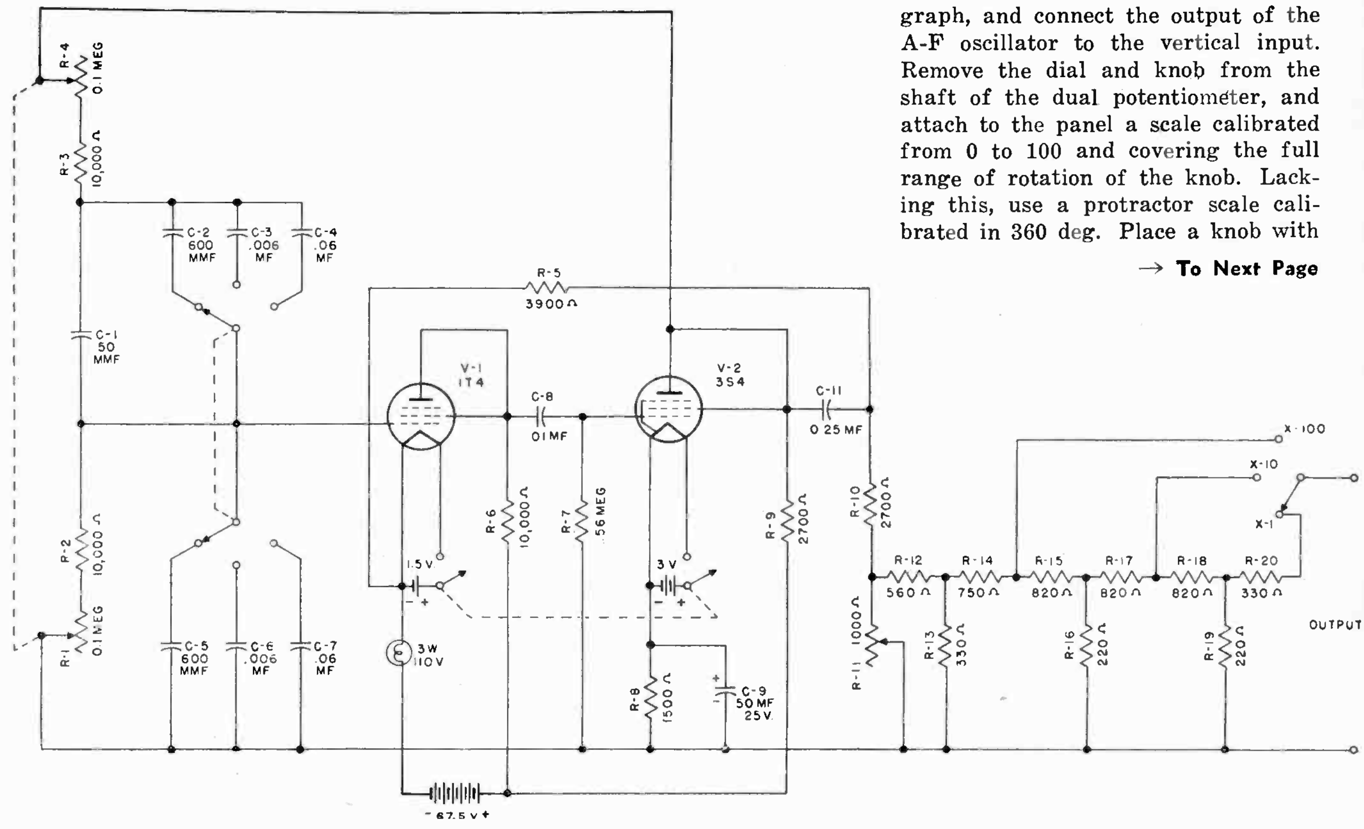


Fig. 2 Complete schematic of the midget audio-frequency oscillator.

MIDGET Auto Frequency OSCILLATOR

→ **From Preceding Page**

pointer on the potentiometer shaft. Turn on the oscillator and the oscillograph, and allow ten minutes for warming up. Adjust the controls on the oscillograph for traces of suitable amplitude, filling approximately 2/3 of the screen. Rotate the dial on the oscillator until the pattern assumes

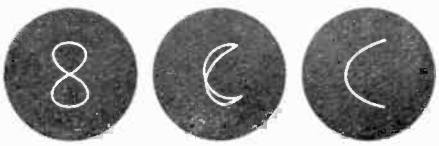


Fig. 3. Three possible forms of patterns obtainable with 2:1 frequency ratio applied to the plates of oscillograph.

the shape of a circle, adjust carefully, and when the circle remains stationary, record the reading of the scale. This point corresponds to 60 cps, or the line frequency. Without changing the controls of the oscillograph, adjust the dial on the oscillator until the pattern resembles those of Fig. 3A, B, or C. Any of these is possible, depending upon the phase of the two signals. The important thing to remember is that the pattern must remain stationary, regardless of which form it takes. When this pattern is obtained, record the scale reading, which corresponds to 30 cps, or one-half the line frequency. Now, adjust the dial still further in the same direction until a pattern like Fig. 4A is obtained; record the reading, and label it 25 cps.

The next operation is a little tricky, but should pose no real problem. Reset the dial on the oscillator until the pattern again becomes a circle. Change the controls of the oscillograph to linear sweep until the pattern of Fig. 4B is obtained. This will indicate that the controls are set for 30 sweeps per second. Connect the 6.3-volt A-C supply to the sync input of the oscillograph, and adjust the sync control to hold the sweep at this rate. Do not change these adjustments for the remainder of the calibrating operation.

Retune the dial of the oscillator to the point recorded for the 30-cps frequency, and the pattern of Fig. 4C should be obtained. Now, adjust the dial to obtain the patterns of Fig. 5, recording the frequency and dial position for each setting obtained. Continue changing the setting of the frequency knob for six, seven and eight full sine waves on the screen, corresponding to 180, 210, and 240 cps respectively. Having located all of these points, plot a smooth curve through the calibrating points on a piece of graph paper, with frequency along the bottom scale, and dial setting along the vertical scale. Then it is possible to note the point at which any frequencies should fall, giving the necessary information to make a suitable dial scale. It is suggested that the dial be calibrated at 25, 30, 35, 40, 50, 60, 80, 100, 120, 140, 160, 180, 200, 225, and 250 cps. After this is done, proceed

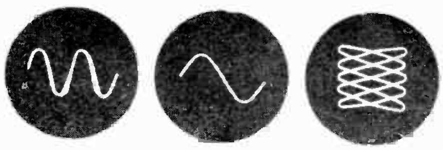
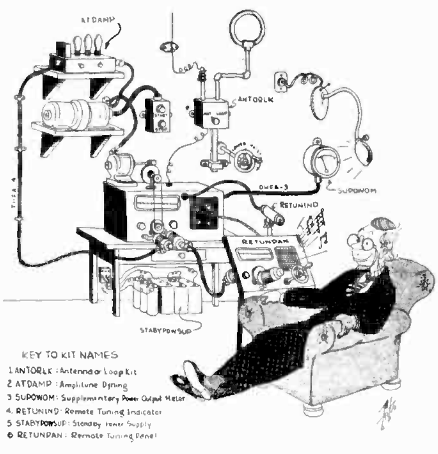


Fig. 4. Additional patterns obtained when calibrating oscillator. (A) represents 5:2 frequency ratio. (B) is the single sine wave obtained when linear sweep frequency is the me as the signal applied to the vertical plates. (c) shows two full sine waves obtained when linear sweep is one-half of the frequency of the applied signal.

with the remainder of the construction as outlined earlier. Once the original calibration is obtained, the scale will be correct for all three positions of the frequency switch so long as the three pairs of condensers are adjusted as described under "construction."



Navy Sonarman returns to civilian life with a lot of brilliant ideas about Modification Kits. Cartoon by W. H. Fritz, Navy Buships Field Engineer.

The uses of an oscillator of this type are myriad, and once you have an audio frequency oscillator available for servicing use, you will not want to be without it. This one is simple enough to make, and should answer the need for a small and highly portable instrument.

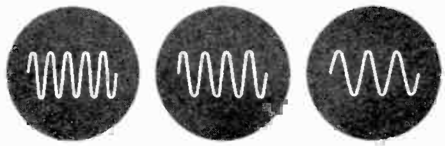


Fig. 5. Patterns on oscillogrph screen corresponding to 3;1, 4:1, and 5:1 frequency ratios.

While detailed instructions for actual construction are not offered, it is felt that the use of whatever type of housing is available, and the use of the builder's own ingenuity will make it possible to adapt the available material to the job effectively. The parts list given is based on the writer's own model, and it is a welcome addition to an already large collection of "home-made" apparata.

Parts List

R-1, R-4, Centralab C-102, dual-100,000-ohm potentiometer
R-2, R-3, 10,000 ohms, 1/2-watt, matched
R-5, 3900 ohms, 1/2-watt
R-6, 10,000 ohms, 1/2-watt
R-7, 0.56 Meg, 1/2-watt
R-8, 1500 ohms, 1-watt
R-9, 2700 ohms, 1-watt
R-10, 27,000 ohms, 1/2-watt
R-11, 1,000 ohm potentiometer, Centralab B-101
R-12, 560 ohms, 1/2-watt
R-13, 330 ohms, 1/2-watt
R-14, 750 ohms, 1/2-watt
R-15, R-17, R-18, R-20, 820 ohms, 1/2-watt
R-16, R-19, 220 ohms, 1/2-watt
C-1, 50 mmf mica
C-2, C-5, 600 mmf mica
C-3, C-6, .006 mica
C-4, C-7, .06 paper (matched, see text)
C-9, 50-mf 25-volt electrolytic
C-10, 0.25 mf, paper (600 volt)
C-8, .01 paper (600 volt)
V-1, 1T4
V-2, 3S4
3 1 1/2-volt unit-cells
1 67 1/2-volt "B" battery (Everready 467)
2 Miniature sockets
1 DPST switch cover, Centralab K-157
2 Mallory switches #3243
1 110-volt, 3-watt lamp
1 Candelabra socket
2 binding posts
2 knobs
1 knob and dial.

If I Were a Serviceman

Some interesting observations on the radio service business by Charles Golenpaul of the Aerovox Corporation.

By Charles Golenpaul

I KNOW I CAN QUALIFY as an expert, writing here to you about the radio service business, because of that definition I like best describing an expert. My friend the wit says: "An expert is one who is just beginning to understand how little he knows about the subject." And that, fellows, is Charley Golenpaul.

Also I can quality as an efficiency expert, because my friend the wit again covers the situation adequately with this definition: "An efficiency expert is one who has no business of his own to wreck." Or putting it another way: "An efficiency expert is one who is smart enough to tell you how to run your business, and too smart to start one of his own." Again your correspondent Charley Golenpaul qualifies in a big way.

I just like to touch on a few subjects vital to our trade, giving you fellows the benefit of what I see and hear and read about the radio service business all over the country, so that your horizons may be extended by just that much. We can always learn something from the other fellow.

My main theme is *Profit*. My friend the wit says "Profits, not *Prophets* foretell the future." And that's the whole story of successful radio servicing in a nutshell.

You fellows are in business. The main point in business is to make a profit. And unless you are vitally concerned about profits, you won't stay in business very long.

Offhand I don't recall exactly what percentage of new businesses survive beyond the first year, nor the second year nor even the first five years. But I do know that most of them die in their infancy. You can get the exact percentages of those business fatalities from your local newspaper or from one of the financial journals. But I can tell you, without gumming up this chat with a lot of dry statistics, that less than 20% of all new businesses survive those first five years. And the reason for the 80% fatalities is simply the lack of profit.

Therefore, first and foremost, remember that you are in radio servicing to make a profit. Of course, if your old man or wife or some other relative has a boodle of money and can stake you indefinitely, that's another matter. But inasmuch as the vast majority of us have to paddle our own canoe, I take it that you've got to make a profit if you intend to keep the sheriff away from your door.

Now *profit* is no simple matter although it sounds so simple. In its most elementary form, profit is simply the difference between what something costs you and what you sell it for. And in servicing, it is *profit* that pays your salary.

However, it isn't easy to figure profit, and even less easy to make a real profit. For example: The parts for that job cost you $1.00. You charge the customer $2.00. You've presumably made $1.00 for yourself. But hold on a minute—you're jumping at false conclusions. And it's because of such hasty conclusions that many servicemen soon go broke.

The parts cost you $1.00 and you got $2.00 for the job. But you didn't make a whole dollar for your own personal services. No indeed. To that $1.00 for parts, you have got to add your *overhead*. By the time the proper overhead is added, the $1.00 cost becomes $1.25 or even $1.50, so that your own earnings are reduced to 75¢ or even 50¢ and very often even down to zero.

Overhead? some of you may ask. Overhead, why there is no overhead, some of you may say. But believe me, fellows, each and every one of you has overhead. Everybody's got overhead. As my friend the wit has it: "It's not difficult to meet expenses these days; one meets them everywhere." Yes, there are expenses to be met in your little setup. You must have some rent to pay. I don't care whether you operate out of a store on Main Street or out of your home basement. There's rent—more or less of it—and that rent must be charged proportionately against every job you handle, as part of the overhead.

Then there are the ordinary business tools. No doubt you've got a telephone. Again, I don't care whether it's your home 'phone or strictly a business telephone. Regardless, in whole or in part, that expense is part of your business overhead.

Then you must have electricity to pay for. Again, it makes no difference whether it's entirely business or part of your home life. Electricity is a legitimate expense—part of your business overhead. And you may have fuel, janitor service, the fellow who shovels the snow in front of the shop, and so on.

And what about traveling expenses? Are you using a car—even if it's the family jallopy? Or do you go by the street car or bus? Regardless, traveling expenses are part of your cost of doing business.

Then there are the books, service manuals, subscriptions to radio publications, memberships in radio organizations, and perhaps a correspondence course and other means of keeping abreast of radio knowledge.

→ To Next Page

IF I WERE A SERVICEMAN

→ **From Preceding Page**

These are expenses—part of your business overhead.

There are your tools, test instruments, service benches, desk, typewriter, file and so on. These items don't last forever; they wear out in time, or again, they become obsolete and must be replaced by newer models. Will you have the necessary money saved when it comes time to replace those items? You will, if you charge off a good percentage of the cost of such equipment each year, and put the money aside as a trust fund. Your income tax permits such a reduction for depreciation.

These and many other items add up to your actual overhead. The total is really astounding. Your actual overhead can easily run 25% to 35%. Therefore, when you figure the cost of a job, include say 35% as your general overhead, include your own personal services or those of the men working for you, on top of the cost for actual materials. You'll then arrive at your actual cost, and the difference between that actual cost and what you get for the job will determine your net profit. And remember, it's *net profit* that keeps all of us going in business.

Right here we have the very essence of most business failures. Too many would-be businessmen simply don't know their costs. They are fooled into believing that gross profits are real profits. Especially these days, when Uncle Sam and local authorities take a healthy slice out of each and every one of us by way of income and business taxes. If you don't watch your overhead costs and make due provision for meeting them over and above your personal weekly

"take," you'll be in the same predicament as the car driver who keeps right on driving blissfully without paying due attention to the gasoline gauge. Sooner or later he's got to get out and walk.

And so the very first point I wish to make is *profit*, and I mean a sound, true, *net* profit. Also, I want to stress over and over again that you've got overhead in your business, no matter how you operate, and you've just got to find out what that overhead amounts to, and then determine what percentage it amounts to on the basis of say $5000 a year or $10,000 a year, or more, as the case may be. Naturally, the overhead percentage comes down somewhat as you do more business. But in any event, you should establish a percentage based on anticipated yearly business, and charge to each and every job you handle that 25 or 30 or 35 percent for overhead.

By this time most of you fellows are saying to yourself: that overhead and profit stuff may be okay, but my trade won't pay for all that freight. So now we go on in our discussion to the justification of fair and profitable prices.

A fair price in this radio servicing game is based on an *honest* repair job and covering the cost of parts, labor, your overhead, and your net profit. Worthwhile trade is willing to pay such a fair price. Those who are unwilling to pay a fair price are just not worth bothering with. And your competitors who cater to these cheap folks simply won't be around very long, I assure you.

The main thing the radio set owner wants is to get that inoperative set going again. When he calls you into the case, you can be sure he's usually fussed around with the trouble himself. He's had that smart son or nephew or brother-in-law monkey around with it too. He's asked that friend who works in a radio factory to look at it. But present-day radios don't respond to such home remedies. The handyman with screwdriver and pliers doesn't get very far these days. It takes test instruments plus a lot of know-how to figure what's wrong with the set—to find that low-emission tube or that broken-down capacitor or that burned-out transformer.

Consider a parallel case: Little Annie is deathly sick, all of a sudden. Mother reads that family medicine book or the old almanac, and tries to fit some stock remedy to Annie's particular symptoms. Then the corner druggist is consulted. One or two patent medicines may be tried. But when all such makeshifts fail, the doctor is summoned. And his word goes. He scribbles some Latin and some numbers on a slip of paper and tells you to get the prescription filled at the corner drug store. There's complete confidence now that Annie will soon get well—even though the doctor knows darn well that nature and nature only will do most of the curing. At any rate, the doctor gets his three bucks for 15 minutes of his precious time, without any argument whatsoever.

Now you as a radio serviceman are very much in the same position. True, no life is at stake, but the family's routine entertainment is dead for the moment and you are the fellow to bring it back to life again. You're the doctor. You've got the savvy. You can make that radio play again. And you're entitled to your fair price.

How do you conduct yourself before customers? That's the real test in getting fair prices. I'll assume of course that you are neatly dressed, polite, businesslike, and speak convincingly. These basic points must be taken for granted. But — and please pardon the question—do you suffer from a *big mouth?* I find that many servicemen simply give away their savvy without realizing it, and having given away their main stock in trade, they are surprised at the loss of business. Let me illustrate:

You are checking a radio set in front of the customer. Incidentally, that's bad business to start with: all sets should be checked at your convenience and when the customer isn't around to bother you. But this is one of those exceptional cases—you've got to check the set while the customer is around. All right. You go to work with your test equipment. You soon find out that a tube has low emission; a capacitor is shot; a resistor is drifting excessively. Knowing what has to be replaced, you figure up the cost of materials, the amount of labor, that matter of overhead, and your fair net profit. You give the set owner the cost. *Period.*

But now there is the big-mouth serviceman who wants to show how smart he is. Or at least he wants to prove that the price is correct. He may point out that this tube, Type XYZ, has to be replaced; that capacitator, an 8-mike 450-volt electrolytic, has to be replaced; and that carbon resistor, 1-watt 100,000 ohms, has to be replaced. He may even go so far astray as to quote net costs on those parts, rather than the full list to which he's entitled on resale. Whereupon foxy Mr. Set Owner says that the price seems kind of high and he'll have to think it over.

Mr. Set Owner in due course turns up at a jobber's store. In professional lingo he asks for a Type XYZ tube, an 8-mike 450-volt electrolytic, and a 1-watt 100,000 ohm carbon resistor. He gets them at your net cost because he speaks the language of the trade, duly taught him by the big-mouth serviceman. And if he's just a shade above a moron, he can install those parts and his set is as good as new again. Whereupon the big-mouth serviceman has done himself out of another job.

Don't talk! Don't give away valuable information. Be as concise as necessary to justify your estimate. That's enough. Remember, the doctor didn't go into lengthy explanations regarding Little Annie's ailment. Nor did he tell the family in plain English what those Latin words and numeral meant on the slip of paper. Nor does the druggist say that the $1.00 prescription could have been compounded at home from such common ingredients as baking soda and common salt at a cost of a couple of pennies, in many cases. No sir! The family is paying for *knowledge*. And that's mainly what you as a serviceman have for sale.

In your estimate or price, you are entitled to full list prices for parts and supplies. You are entitled to be paid for your time, even if it's only to check a set and give an estimate away from your shop. You are entitled to charge for your time the moment you leave your shop until you get back. Remember, doctors don't make many free calls.

Get fair prices for your jobs. Make a decent profit. But this does not mean that you are licensed to cheat or gyp. Cheating or gypping is the other extreme of working for nothing. And one extreme is as bad as the other.

Some servicemen don't take any chances with the making of ample profits. They just work customers for all they can get. The Reader's Digest, a few years ago, turned up some very flagrant cases of this sort and for a time made it pretty bad for all servicemen. We just cannot afford to have that sort of reputation get around.

Cheating or gypping just doesn't pay in the long run. I've seen one serviceman after another go out of business because customers were simply robbed.

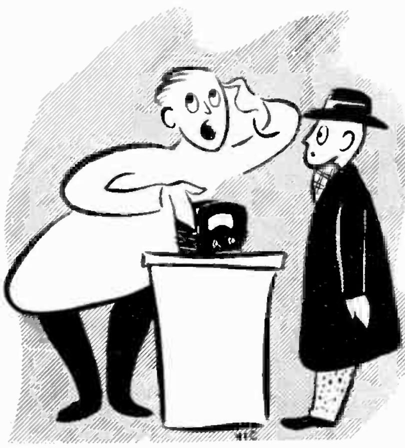
Today there is enough legitimate work to go around. We can well afford to be honest. So why tell a set owner that the job will cost $10 when all that is necessary is to solder a broken connection or push a loose tube down into its socket or tighten the antenna binding post that has become loosened. Of course the serviceman is entitled to charge for the call, no matter how simple the trouble may prove to be. But between such a legitimate fee and the charging of many extra dollars on trumped-up defects, there is all the difference between an honest living and downright crookedness.

The fact that a serviceman is a gyp gets around mighty fast. If the gyp is set up in a trailer and therefore can shift from place to place, he doesn't have to worry too much what people will think after a while. But if he's set up permanently in a community, then good reputation is an essential asset.

The *right* price for a job is that which constitutes a real bargain to you and to the customer. As my friend the wit puts it, "A bargain is a transaction in which each party thinks he has cheated the other." I rather like that definition although it is a bit smelly. If the customer thinks your price is reasonable, and you know you've made a fair profit, then it's really a bargain.

But to insure that bargain, it is necessary that your job stand up as it should. There are some servicemen who don't give a rap whether the job stands up or not, provided they have been paid. That's just another form of gypping, and leads to hard feelings and eventual exit from business.

If the set owner has paid your price without quibbling, he's entitled to have the repair job stand up for six months or a year. However—and this is a point I wish to emphasize—it is well to state in your bill, and even on a sticker fastened to the chassis, just what repairs have been made. I also like the idea of putting stickers on tubes that have been replaced, with the dates. If the set then breaks down from some other cause, the reasonable set owner can readily understand that you are not at fault. Also when you estimate on a repair job, it may be well to specify what you are going to do in general terms (don't give away the



"savvy"), and also to mention other things that might be attended to for a 100% repair job, but which are not included in this particular estimate.

In connection with making those jobs stand up, I cannot emphasize too much the importance of using the best parts or components. There are many servicemen who are still penny-wise-pound-foolish to the extent of buying the cheapest parts they can find. And that situation is aggravated today when surplus war stuff is finding its way to the radio parts market. Or course, I realize the temptation it is to pick up 8-mike electrolytics for a dime apiece and power transformers for a half-dollar. But remember, fellows, you usually get just what you pay for. Much of that surplus stuff is just plain junk by now. It is usually sold "as is." Most of this war stuff was made several years ago. Much of it has been stored under questionable conditions.

Some of it has been used and even abused. You certainly take an awful chance when you install such unknown parts. It may be all right to use the junk in your own assemblies over which you have full control, but to put that stuff into customers' radios is simply to gamble with failures and bad feelings and the loss of money and good will. You can squander many times the few pennies you may have saved at first.

I cannot warn you too much on this point. If you would play safe and sound, continue to buy branded merchandise in original packages, carrying the manufacturer's original guarantee and not an outdated guarantee either. Don't be misled by those so-called war surplus bargains.

Lastly, keep your knowledge and equipment up to date. I cannot urge too much the importance of sound training in this servicing business.

→ To Page 28

An Equalized Amplifier for Magnetic Pickups

One means of properly equalizing the output of a magnetic pickup to take advantage of full frequency response recorded on present-day phonograph records, and to give the proper balance between lows and highs.

By E. S. Cross

IN the reproduction of disc recordings, it is necessary to compensate for a number of factors in order to make the playback a reasonably exact reproduction of the original. The most important of these factors is probably the recording characteristic. With crystal pickups, the output of the head is proportional to the amplitude of the cut, approximately; whereas, with magnetic pickups, the output is proportional to the velocity of the needle at any given time. Inasmuch as most commercial pressings are cut with a constant amplitude characteristic up to about 300 cycles, and with a constant velocity characteristic from 300 to, let us say, 7000 cycles, it is obvious that the average pickup will not give a flat output from such a pressing. It would seem as though the ideal reproducer would be one which had the characteristics of the crystal type up to 300 cycles, and of the magnetic type from 300 cycles up.

From a practical standpoint, it is more logical to assume the use of a certain type of pickup, and to equalize for its characteristics. With the crystal it is necessary to use an equalizer which is essentially flat up to 300 cycles, and rises 6 db per octave above that point. This is the common method as used by most of the phonograph manufacturers, and it is relatively inexpensive, using only one or two condensers of small capacity, and two or three resistors. The magnetic pickup requires an equalization curve flat from 300 cycles up, but increasing at the rate of 6 db per octave below 300 cycles, or a total of 20 db at 300 cps.

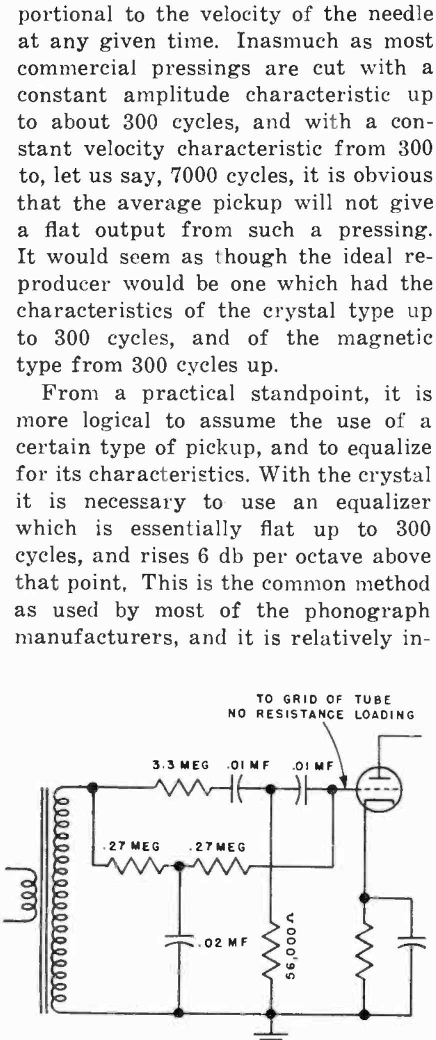


Fig. 1 R-C network in grid circuit of input stage to compensate for droop in low-frequency response of magnetic pickups.

This type of equalization may be achieved in a number of ways, one of which is shown in Fig. 1, which gives rather more than the required amount, and with but few parts. The curve for this equalizer is shown in Fig. 2. While this furnishes an equalization of some 26 db at 30 cycles, the loss due to the network, (at 1000 cps) is nearly 45 db. In the case at hand, this would necessitate the addition of an amplifier stage to compensate for the insertion loss of this circuit.

For one particular application, several conditions had to be met. The impedance of the pickup to be used was given as 22 ohms at 1000 cps. The output was so low that at least 15 db of gain was necessary to bring it up to where it could be used with existing amplifiers. This indicates that at least 35 db of gain must be supplied in order to equalize 20 db at the low end. In addition to these conditions, the required amplifier should be battery operated, and as small as possible. The output impedance was to be 200 ohms.

These requirements dictated the use of a two-stage amplifier, with transformer input and output. A careful inspection of the available battery operated tubes gave promise of a really small amplifier by using the miniature types. No general purpose triodes are in this series, so tests were made to determine the usuability of the 1T4, nominally an R-F pentode, connected as a triode. Its plate family is shown in Fig. 3, with a load line for a 15,000-ohm load. The operating point selected was with a grid bias of 1.5 volts, which would be easy to obtain, and at which point the tube had a plate resistance of 13,000-ohms, a μ of 9.8, and a mutual conductance of 800 micromhos with 1.3 ma of plate current. From the plate family, it is possible to calculate the power output and distortion, giving 1.4 milliwatts output at 4.5% harmonic content. The maximum output required from this amplifier was to be -2 vu, which is 0.63 mw, easily met by the calculated output.

Having selected the output tube, the obvious choice for the first tube in the amplifier was the 1S5, diode and audio pentode. The tube data for this type show a voltage gain of 30 when operating into a load of 1.0 megohm, with a 1.0 megohm grid leak for the following stage. The screen was supplied from the 67.5-volt source through a 3.3-megohm resistor.

It was decided to operate the filaments of the two tubes in series from a 3-volt source, and by having the 1T4 at the positive side, its bias could be obtained from the drop across the 1S5 filament, giving the required 1.5 volts. There are a number of battery packs that will furnish these voltages.

The input transformer selected was the UTC A-14, a small input unit designed for use from a 30-ohm microphone to a 50,000 ohm grid. The output transformer used was a UTC A-24, similar in size and appearance, and connected for 200-ohm output. The calculated gain of the amplifier was 49.5 db without feedback, which was the method used to obtain the desired

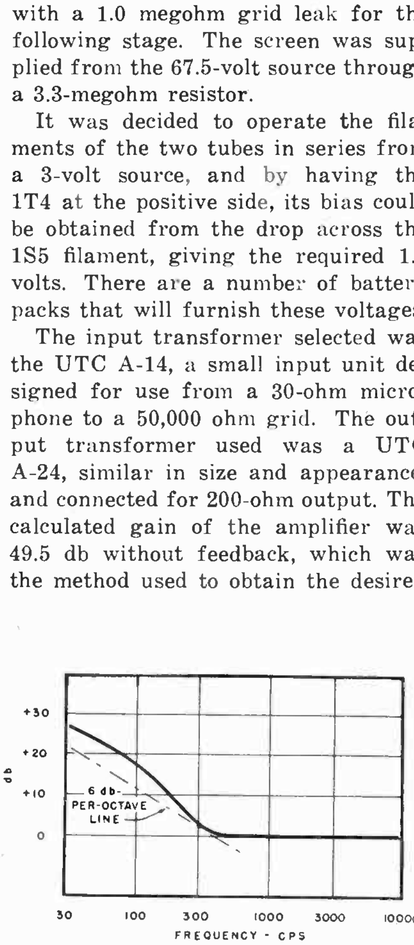


Fig. 2 Frequency response curve for network.

equalization. The gain was calculated as follows:

$$V.G. = \sqrt{\frac{50000}{30}} \times 30 \times \frac{9.8 \times 15000}{15000 + 12000} \times \sqrt{\frac{200}{15000}} = 772$$

where the first radical indicates the voltage gain due to the impedance step-up ratio of the input transformer; 30 is the published gain of the 1S5 as an audio amplifier; the fraction represents the voltage gain of the 1T4 under the conditions described above; and the second radical represents the voltage loss due to the impedance step-down ratio of the output transformer. The gain in db is calculated as follows:

$$\text{Gain (db)} = 20 \log \left(772 \times \sqrt{\frac{30}{200}}\right) = 20 \log 298 = 49.5 \text{ db}$$

The radical in this formula is used to convert the impedance of the input to that of the output, a necessity in calculating gain in db. To design the circuits of the amplifier for this type of frequency correction, it is necessary to go through several operations. With filament type tubes, the feedback can best be returned to one place, i.e., the grid circuit of the first tube. With transformer input, the logical place is at the ground end of the secondary. Assuming an input voltage of 0.1 volts to the grid of the input tube for calculation purposes, the output voltage Eo at the secondary of the output transformer is

$$Eo = 0.1 \times 30 \times \frac{9.8 \times 15000}{15000 + 12000} \times \sqrt{\frac{200}{15000}} = 1.87 \text{ v.}$$

If N db of feedback is added to an amplifier, the gain is reduced by that amount, so that the input voltage must be multiplied by $\log^{-1} N/20$ to achieve the same output. Calling this value K, the voltage to be fed back is (K − 1)Ei. For 25 db of feedback, K is 16, and it becomes necessary to feed back (16 − 1) x 0.1 v. or 1.5 volts, for the proper equalization. In order to equalize, the transmission characteristic of the feedback circuit must be the inverse of the desired curve; or in other words, the feedback path must have a transmission characteristic equal to the source it is intended to correct. This is met by a resistor and condenser in series, with the values of the components adjusted so that the resistance equals the reactance of the condenser at the frequency at which the curve should deviate from flat by 3 db. For a .05 mfd condenser, the resistor should be 15,000 ohms. At 1000 cps, the reactance of a .05 mfd condenser is 3200 ohms, and the voltage across the resistor, with the two elements in series, is

$$\frac{1.87 \times 15000}{18200} = 1.54 \text{ volts, which is}$$

close enough for a start. Actually, it turned out very well except that the amplifier put out a +6 vu signal which could not be heard at all, but which could be measured. It was found to be at 16,500 cycles, and was cured by the addition of a 400-mmf condenser from the grid of the 1T4 to ground, giving sufficient phase shift to eliminate the oscillation, but, being within the feedback loop, not affecting the frequency response. Further low frequency boost was given by a .01 mfd condenser in series with 75,000 ohms across the secondary of the input transformer, which added approximately 3 db at 30 cps. Figure 4 shows the circuit of the completed amplifier,

→ To Page 29

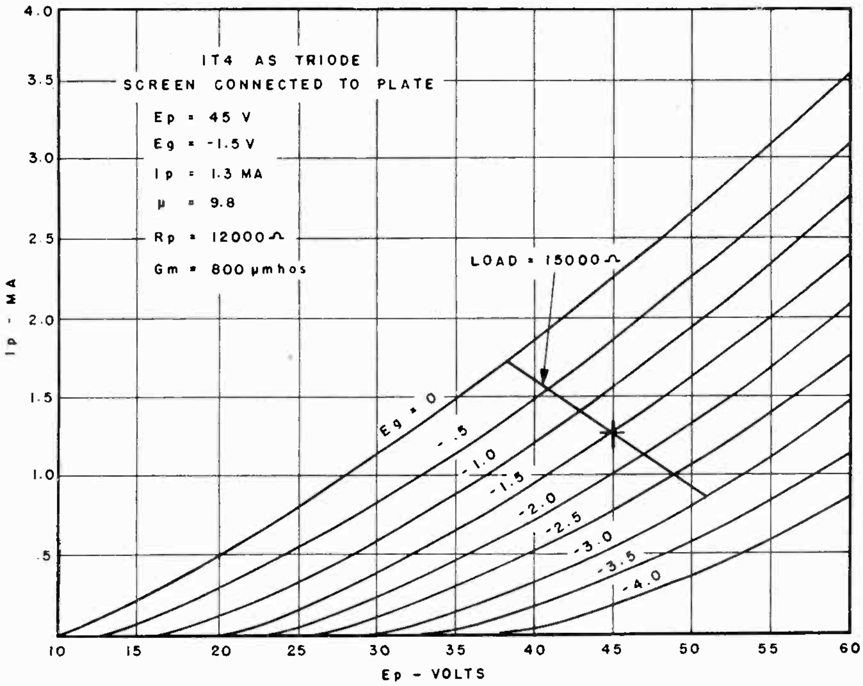


Fig. 3 Plate family for 1T4 connected as a triode.

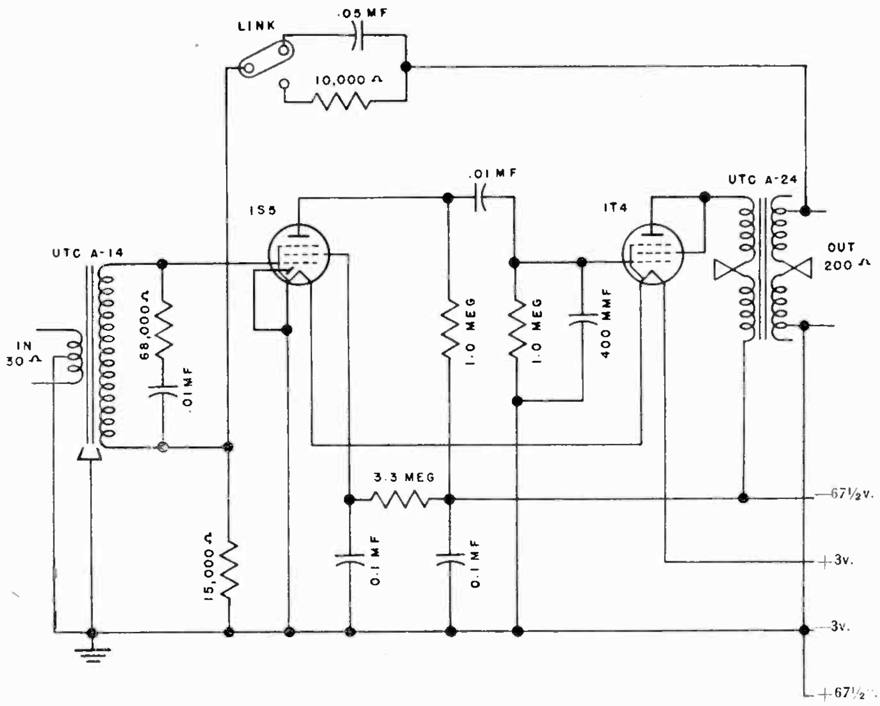


Fig. 4 Schematic of complete amplifier, equipped with link to provide flat or equalized operation of the amplifier.

ELECTRONICALLY SPEAKING

An increase of several hundred per cent in jobber business is reported by Leon Adelman, advisory sales manager of Clarostat Mfg. Co., Inc., Brooklyn, N. Y.

"Clarostat jobber business is at an all-time high but still climbing week by week. Only recently we established a jobber stock at our North Sixth Street plant, whereby we could carry a considerable inventory of standard jobber items for prompt delivery. Our two plants have had big production runs on such items, and we figured our jobber stock would tide us over many months. Instead, the inventory has been quickly accounted for and our plants have had to keep right on producing for jobber stock."

"Our postwar catalog is now rolling off the press. It lists the widest choice of resistors, controls and resistance devices Clarostat has offered in years. Any of these listed items are available for prompt delivery. We mean to contribute our share to the immediate re-establishment of normal and profitable servicing, as well as the building of new equipment by servicemen, amateurs, experimenters, laboratories, small equipment builders, and schools."

Delivery of the first postwar Scott radios to franchised dealers throughout the United States was completed by the middle of February, it was announced by E. J. Halter, vice-president of the Scott Radio Laboratories, Inc., of Chicago. The model that will be available at this time is the Scott 800, selling in the neighborhood of nine hundred dollars.

The Scott 800, like Scott's other models, incorporates a high fidelity radio-phonograph combination and the new Teague dial. With a total of 24 tubes of the latest type, it is designed to reproduce the entire frequency range transmitted, with particular emphasis given to the reception of FM broadcasts and fine quality recordings.

The Teague dial combines beauty and flexibility. Designed by Walter Dorwin Teague, leading New York industrial designer, it provides the maximum in precision tuning and fingertip adjustment through seven highly calibrated control knobs. This dial rests inside the cabinet when not in use and rolls out for tuner convenience.

Two prominent electronics engineers have, thru the modern miracle of Electronics, just invented and produced a revolutionary radio receiver that, besides providing radio entertainment, also carries your voice over electric light wires from point to point without special inter-connecting wires. By simply plugging it into the nearest electric light socket, you can talk instantly to another person who has a similar instrument in another room or office, or on another floor—even in the basement or garage. There are no wires to install.

Mr. Levy of Lectradio Corp. is the originator and patentee of this new means of plug-in intercommunication over the power lines which requires no additional wiring installation. He has patents issued in the United States, Canada and seventeen foreign countries.

These instruments operate on the principle of carrier-currents, superimposed on the electric light wires. Each instrument, when talked into, becomes a small radio frequency transmitting station which delivers "wired radio" to the electric light circuits. The voice can be picked up, amplified, and reproduced through a loud speaker without distortion or loss of distinction. So sensitive are these instruments, that a person talking in a natural conversational tone of voice at five or ten feet distance, can readily be heard.

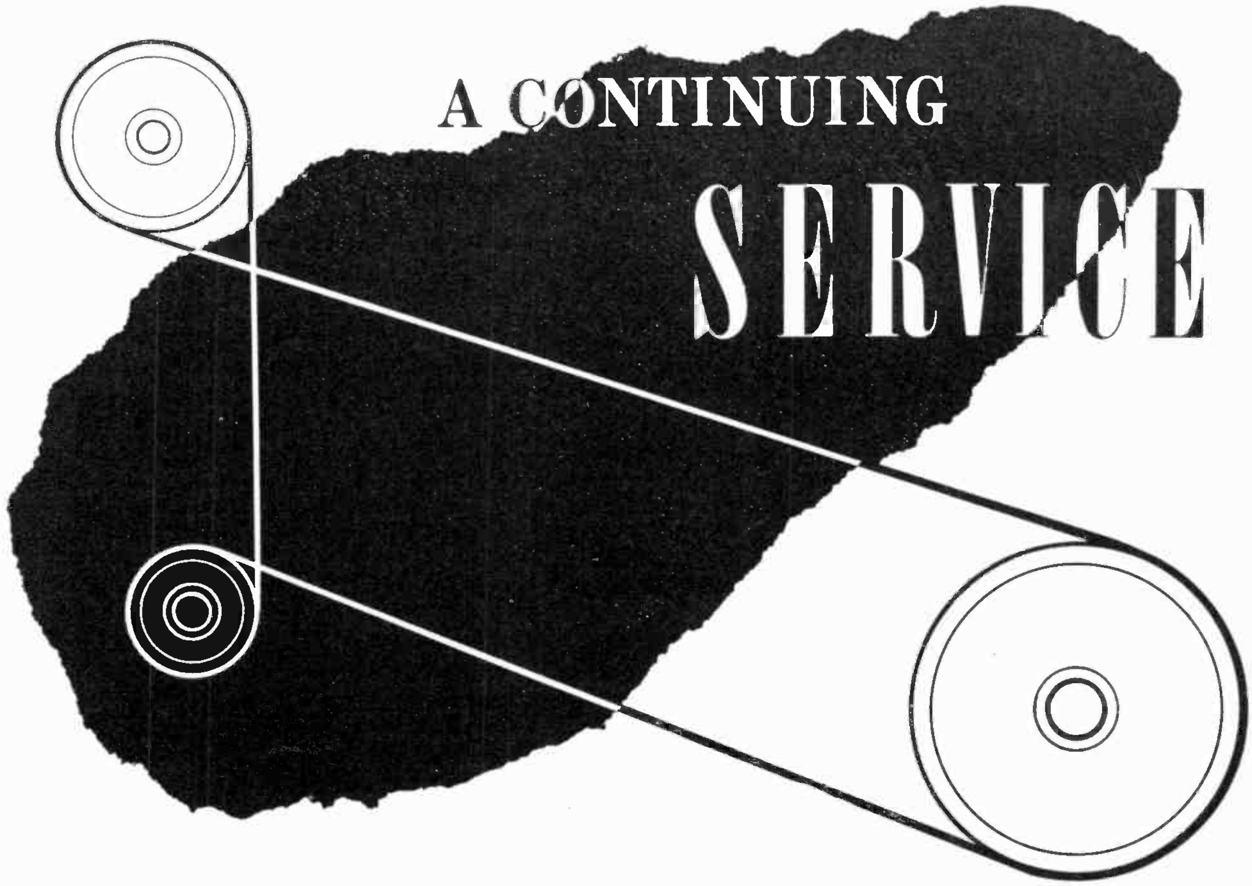
Anticipating an annual gross business of possibly $50 million a year, the Amateur Radio Activities Section, which is a part of the RMA Parts Division, discussed general plans for standardization of equipment and service to radio amateurs here and abroad. There were 60,000 radio amateurs licensed before the war in the United States and thousands more in foreign countries. The FCC and the radio industry expect a revival of interest in "Ham" radio with the return of thousands of GI's who during the war obtained experience in radio and radar communications.

The fellow who says "it doesn't amount to a hill of beans" has never tried to sort one. Otherwise, he'd know that a hill of beans is nothing trivial. But aided by one of the growing industrial uses of electron tubes, the formerly tedious task becomes a speedy, foolproof, automatic operation.

Equipped with a couple of RCA phototubes for eyes and an RCA cathode-ray tube for a brain, the electronic sorting machine, according to the Tube Division of the Radio Corporation of America, "looks" at each bean individually and separates the good ones from the bad ones much faster and more accurately than could human sorters.

Under the system developed by the Army Air Forces and G.E., radar equipment in a plane constantly

→ To Page 31



Rider Manuals are not just bound pages of radio schematics; they are more than static pieces of servicing equipment. Rider Manuals are living things! Working hand in hand with successful servicemen for the past sixteen years they have become an unchallenged institution in the servicing industry.

In spite of this leadership, Rider Manuals are constantly being improved with the sole aim of making still easier, the diagnosis and repair of faulty receivers. For example, in preparing the material for Volume XV we are doing things with the diagrams which will furnish information not normally appearing on, or in conjunction with, such diagrams. This additional information alone will save a serviceman hundreds of hours a year; time which will be worth ten times the cost of the Manual. Rider Manual owners also enjoy continuing benefits from the findings of the staff of engineers employed in the Rider Laboratories of "Successful Servicing," the technical business paper published by John F. Rider. "Successful Servicing," sent free upon request, keeps you up to date on all developments in all phases of the servicing field.

So, your purchase of a Rider Manual, any volume, is not the end of a transaction; it is only the beginning of a chain of benefits that add up to an invaluable and continuing service.

Although your jobber may not have every volume number you want, please understand his position—and ours. We are doing everything possible to get them to you at the earliest possible date. Place your order to enjoy priority.

JOHN F. RIDER PUBLISHER, INC. 404 FOURTH AVE., N. Y. 16, N. Y.

Export Division: Rocke-International Electric Corp. 13 E. 40th Street, New York Cable: ARLAB

RIDER RADIO BOOKS KEEP YOU UP TO DATE

Just Out...INSIDE THE VACUUM TUBE...424 Pages, $4.50

RIDER MANUALS (14 VOLUMES)

Volumes XIV to VII . each volume $15.00

Volume VI 11.00

Abridged Manuals I to V (1 volume) 17.50

Automatic Record Changers and Recorders 9.00

The Cathode Ray Tube at Work
Accepted authority on subject . . 4.00

Frequency Modulation
Gives principles of FM radio . . . $2.00

Servicing by Signal Tracing
Basic Method of radio servicing . . 4.00

The Meter at Work
An elementary text on meters . . . 2.00

The Oscillator at Work
How to use, test and repair 2.50

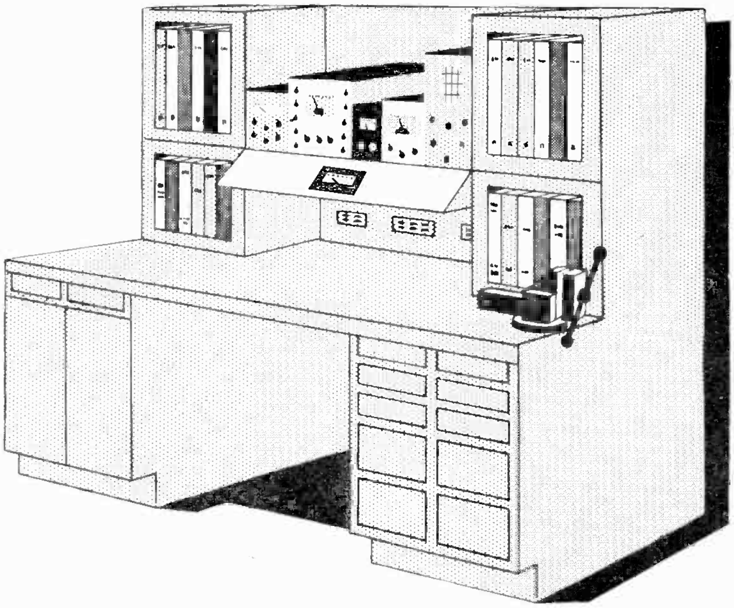
Vacuum Tube Voltmeters
Both theory and practice 2.50

Automatic Frequency Control Systems
—also automatic tuning systems . . $1.75

A-C Calculation Charts
Two to five times as fast as slide rule . 7.50

Hour-A-Day-with-Rider Series—
On "Alternating Currents in Radio Receivers"
On "Resonance & Alignment"
On "Automatic Volume Control"
On "D-C Voltage Distribution" . 1.25 each

The Radio Service Bench

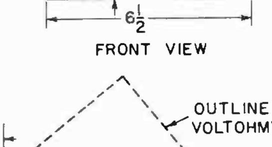


IT is with great pleasure that we turn this month's Radio Service Bench page over to readers who have suggestions that are, in our opinion, worth calling to the attention of others. As a matter of fact, we are of the opinion that this page should always be turned over to the reader for ideas that may help solve a tricky problem or to save a few minutes of time. For this reason, we have awarded a year's subscription—or extend the present subscription for one year—to the contributors whose ideas make up this page.

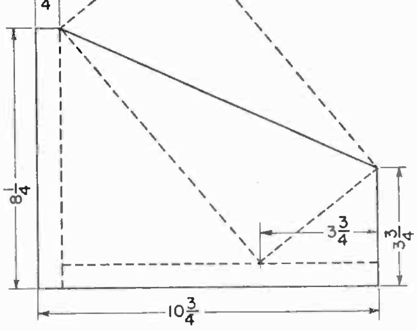
John K. McCord, of 48 Franklin St., Medford, Mass., has a simple and useful means for curing a trouble that is prevalent in AC-DC sets. Many of these common radios have their dial lights across a tapped section of the line cord or across a section of a tapped ballast tube, or from a 35Z5 rectifier tube. When this tapped section burns out, as it sometimes does when the set is operated for a prolonged period after the dial light has burned out, it is sometimes difficult to make a repair with an exact replacement. Tapped line cords are not always plentiful, and 40-ohm resistors to shunt across the dial light are not always on hand.

Many of us have the habit of saving odd bits of salvaged material from repair jobs on the theory that "we might need it some time." Defective line cords removed when repairing other AC-DC sets can be used in an emergency for the dial light shunt resistor.

Usually at lest several feet of a defective line cord are usable. Cut off about a foot at random and measure the resistance with an ohmmeter. Dividing the resistance by the length will give you the resistance per inch of this particular cord. Then re-cut it to the required length for 40 ohms, or any desired resistance, leaving one extra inch for terminal connections. Slide the braid down for a half inch on each end, and then unravel the resistance wire and retwist it around the bare end of *one* of the solid conductors. On the other end, twist the resistance wire around the barbed wires of the *other* solid conductor. Dress the ends of the length of wire with serving twine, or with a piece of narrow friction tape. This will give a neat, flexible fixed resistor which can be fitted into the bottom of a chassis. The heat dissipation will be better than from a fixed resistor of conventional type.



FRONT VIEW



SIDE VIEW

L. Stein of Leading Radio & Appliance Co., Mt. Vernon, N. Y., offers the following hints which help in chasing those elusive gremlins in radio servicing. When Zenith portables fade or go dead on the high end of the dial, try a new 1LA6. When automobile sets which use 0Z4 rectifiers fade or go dead, replace the 0Z4.

Excessive motor ignition noise is often encountered with 1940 Chevrolet auto sets, even after all standard noise suppression methods have been followed. This may be eliminated in most cases by running a self-tapping screw through the bottom of the dash into the side of the radio case, thus grounding the case to the dashboard. Funny how such a simple thing will do the job, after hours of trying the more obvious cures. This is a cure which should be kept in mind for similar troubles.

N. Burgett, manager of Burgett Radio Repair Service of 4955 N. Western Ave., Chicago, Ill. suggests that the RCA VoltOhmyst Jr., or the newer VoltOhmyst Model 195 are more readable on the service bench when they are placed on a mounting jig, such as shown in Fig. 1. For those who have used the original VoltOhmyst, with its inclined front panel, the utility of the jig can be readily appreciated.

Curtis H. Applebaum, 4240 Toledo Avenue, Minneapolis 16, Minn. submitted this idea for consideration, and

→ To Page 28

OL' PROF. SQUEEGEE DID THE JOB

... way back when

PROFESSOR SQUEEGEE SMASHES THE ATOM

After walking to his desk, Professor Oswald Z. Squeegee, PDQ., COD, carefully wound his watch, dropped it into the cuspidor and tucked his chew into his vest pocket. Then he faced the eager, upturned faces of his class.

"Listen to me, you intolerable numbskulls," he shouted. "Today we're going to study the Atom. What's more, we're going to smash the Atom right here in this room. S'help me!"

The Professor paused, reached for a coughdrop, got an eraser by mistake and chewed it vigorously. Then he cleared his throat and continued:

"The Atom, as you ought to know but probably don't, is the unit of all matter. It is the alpha of everything—the smallest, theoretically indivisible portion into which anything can be divided and still maintain its identity. In that respect, it is a good bit like the salaries most of you will earn when you graduate—if you ever do.

"How to smash the Atom has long puzzled scientists, including myself. However, we won't go into that today. Instead, we'll deal with an entirely different type of Atom—the Sprague Atom Dry Electrolytic Condenser, appropriately named for its small size and great durability. This, however, is a type of Atom that *can* be smashed. What's more I'm gonna smash it!"

After ten minutes search, the Professor finally found an 8 mfd. 450 volt Sprague Atom in his cigar case—also a similar midget dry electrolytic of another make. These he connected into a weird electrical circuit on his desk. Then he slowly turned on the juice.

"Now," he gloated, "both condensers are rated at 450 volts and that's exactly what they're getting. As you see, nothing happens. We'll step the voltage up to 500. Now up to 525. Note that the other condenser is beginning to sizzle, although the Atom is still in good shape. Here we go to 550 volts—now to 575—now to—goodness me!"

There came an explosion not unlike that of a giant firecracker and the heads of the class suddenly disappeared beneath their desks.

"You're all wrong," shouted the Professor gleefully after order had been restored. "You thought I smashed the Atom—but I didn't. It was the other condenser that blew up—not the Atom."

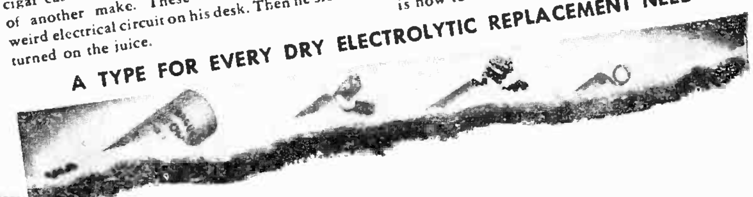
Sure enough, the Atom on the desk was still connected—now hissing a bit under the strain of over 600 volts but functioning perfectly.

"The Atom," continued the professor, "is especially protected against blow-outs—against moisture, heat and whatnot. The way to smash the Atom is not merely a matter of overloading it. The way to smash the Atom is this."

The professor grasped an axe hung over a sign "Use only in case of fire." Swinging this with the skill of a woodchopper and shouting wildly all the while he brought the blunt end down on the Atom—again and again and again.

"There!" he screeched, gleefully looking at the shattered remains. "We've done it. We've succeeded where others have failed. That, gentlemen, is how to smash the Atom. Class dismissed."

A TYPE FOR EVERY DRY ELECTROLYTIC REPLACEMENT NEED



Professor Oswald Z. Squeegee is peeved. Extracts from a recent letter carefully typed on asbestos paper and perfumed with brimstone follow: "Listen here, you jerks. Isn't it about time I got credit as the first man, or reasonable facsimile thereof, ever to smash the Atom? Blow the dust off your files and you'll find I did the job way back in 1940 long before most folks even knew an atom from a dehydrated potato . . ."

And ol' Prof. Squeegee is right! Herewith is reprinted the Sprague advertisement of almost six years ago wherein mention was first made of his startling achievement. Credit where credit is due!

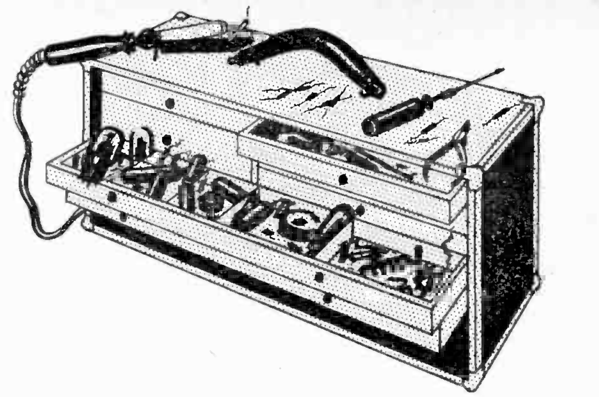
(NOTE: Sprague Atoms are even better today than when Prof. Squeegee performed the now famous experiment. Would he accept a challenge to repeat it now?)

SPRAGUE PRODUCTS COMPANY

NORTH ADAMS, MASS.

JOBBING DISTRIBUTING ORGANIZATION FOR PRODUCTS OF THE SPRAGUE ELECTRIC CO.

Service Kit



Trouble-shooting Noisy Receivers.

IN discussing the subject of noise in radio receivers, a major handicap for both author and reader presents itself in the lack of precise, definitive, technical terms to describe the symptoms accompanying noisy reception. To speak of "buzzing", "scraping," and "frying" is apt to be high misleading and ambiguous—especially to the man possessed of limited experience.

In this article, an attempt will be made to treat the subject in general terms, placing major emphasis on cause rather than on effect.

Perhaps the most acceptable procedure will to define as "noise" any type of spurious response that is received simultaneously with the desired signal, and to proceed from here to discourse on some of the specific defects that will cause noise thus defined.

In accordance with convention, the sources of noise will be divided into two broad categories: internal sources within the receiver itself, and sources external to the receiver. This suggests that the first step in the trouble-shooting procedure might well concern itself with the elimination of one of these sources in the interests of saving time and effort.

As will be shown later, noise caused by external sources will enter the receiver by either or both of two paths: the power line or the antenna. If, upon removing the antenna lead-in and shorting the receiver input terminals, the noise is eliminated, then the noise is obviously entering through this path.

To eliminate the power line as a source of noise, place a noise filter (construction of which will be described in a later article) between the receiver and the power outlet and observe the effect upon the noise. If shorting the receiver input and installing the line filter has no appreciable effect upon the noise, then the receiver must be at fault.

Noise originating within the receiver is generally easier to locate than external noise since considerable aid may be obtained from test instruments, particularly the oscilloscope. For this reason, internal noise will be dealt with first.

Perhaps the most common and obnoxious type of noise originating within the receiver is hum. The "garden variety" of hum caused by open filter condensers in the power pack will receive no mention since it is presumed that even the novice can quickly recognize and trace it. Instead, some of the more obscure causes will be studied.

A very common cause of hum is the potential between cathode and heater in indirectly heated tubes. If, due to circuit design, a large potential exists between heater and cathode the tube may develop a small leakage current between heater and cathode. This leakage current flowing in the cathode circuit may modulate the signal current and be amplified by successive stages. Even a very minute leakage current will produce a sizeable voltage if it flows through any large resistance in the cathode-to-ground circuit. If the tube circuit employs a cathode resistor of high value, it must be adequately by-passed. This gives rise to the possibility of hum generation by open or partially open cathode by-pass condensers. Cathode-heater leakage will not be revealed in any but the best tube testers, and the only satisfactory test is the substitution of a good tube.

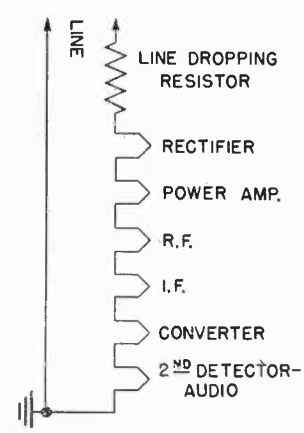


Fig. 1. Typical tube sequence for series-operated filaments.

The presence of R.F. in the power line can cause hum if it is allowed to enter the rectifier tube. This type of trouble is more common in transformerless sets. Here a small condenser across the line prevents R.F. from entering the rectifier. Again, hum will be caused by an open or partially open condenser.

In cities having extensive D-C districts, "conversion work" is very common. It is presumed that servicemen who possess enough radio knowledge to convert an A-C receiver to AC-DC operation realize that the *sequence* in which tube filaments are wired is of great importance. However very serious cases of hum have been caused by failure to observe the proper sequence. The trouble arises from the fact that with series connected filaments, it is inevitable that some tubes will have a large A-C voltage between filament and cathode. Therefore those tubes which are most susceptible to hum must be placed nearest the ground end of the filament string. For the benefit of those who may have to do "conversion" or to service converted sets, the recommended sequence is shown in Fig. 1. Note that the second detector-audio tube, which is the most critical to hum, is placed at the

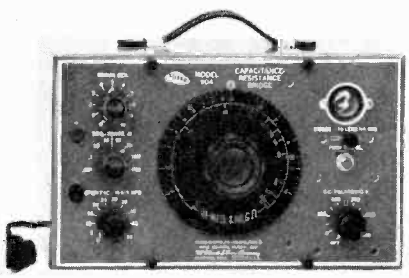
→ To Page 30

THE INDUSTRY PRESENTS

DRESS UP YOUR WINDOW

Garod Radio Corporation launches its 1946 merchandising and point-of-sale campaign with announcement of the Garod "Authorized Dealer Identification Program" according to Lou Silver, sales manager. "The Garod Dealer has the choice of several planned promotion packages, or separate display pieces, to fit the need of his individual store," explained Mr. Silver.

Further information may be obtained upon application to the Garod Radio Corporation, 70 Washington Street, Brooklyn 1, N. Y.



NEW CAPACITANCE-RESISTANCE BRIDGE

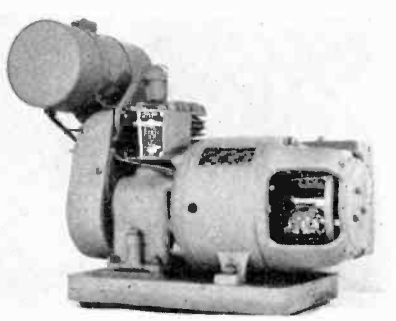
The McMurdo Silver Company announces the model 904 Capacitance-Resistance Bridge which provides accurate measurement of all values of capacitators . . . air, ceramic, mica, paper, oil, electrolytic, etc. . . . and resistors, to be used in the design and servicing of complex post-war radio and electronic apparatus.

Model 904 is direct reading in capacitance and resistance upon a 5" diameter "logarithmic" dial of substantially constant percentage accuracy. A total of eight 100:1 ranges, four for resistance and four for capacitance, cover 10 ohms through 1000 megohms and 10 mmfd. through 1000 mfd. Capacitance down to ¼ mmfd. and resistance to ¼ ohm are directly and accurately measurable as the increment they add to any convenient small value of C or R simultaneously connected to MODEL 904 Bridge. The unusually open dial scale makes measurement of low values easy and accurate. Each of the two high C and R ranges employs a special "expanding" circuit added to the basic Carey-Foster bridge to reach 1000 megohms/mfd. accurately. Sensitivity control permits optimum accuracy of null indication over the tremendous range of MODEL 904.

MODEL 904 enables direct measurement of all types of capacitors with from 0 to 500 volts internal d.c. potential applied *during* measurement. One terminal of the unit being measured may be grounded . . . thus capacitors may be measured without removing them from apparatus in most instances.

The power factor control is calibrated directly in % power-factor, 0-50% for .1 through 1000 mfd., and 0-.5% for .001 through .1 mfd. Power factor accuracy is 5%.

MODEL 904 C-R Bridge draws 35 watts from any 105/125 volt, 50/60 cycle a.c. line. Net Price $49.90. They are manufactured by McMurdo Silver Co., 1204 Main Street, Hartford 3, Conn.



NEW BATTERY CHARGER

The Kato Engineering Company, Mankato, Minnesota has recently begun making deliveries on a new model battery charging engine generator set using the well-known Briggs and Stratton model NP engine having 2" bore, 2" stroke, one-gallon fuel tank, float feed carburetor, gravity feed sensitive flyball governor which permits adjusting charging rate.

The generator is bolted to side of engine crankcase. Drive end of armature is piloted on to engine crankshaft. Grease sealed ball bearing carries outer end of armature.

The plant is self-cranking. Engine can be cranked by hand in case batteries are too low. Engine has magneto ignition.

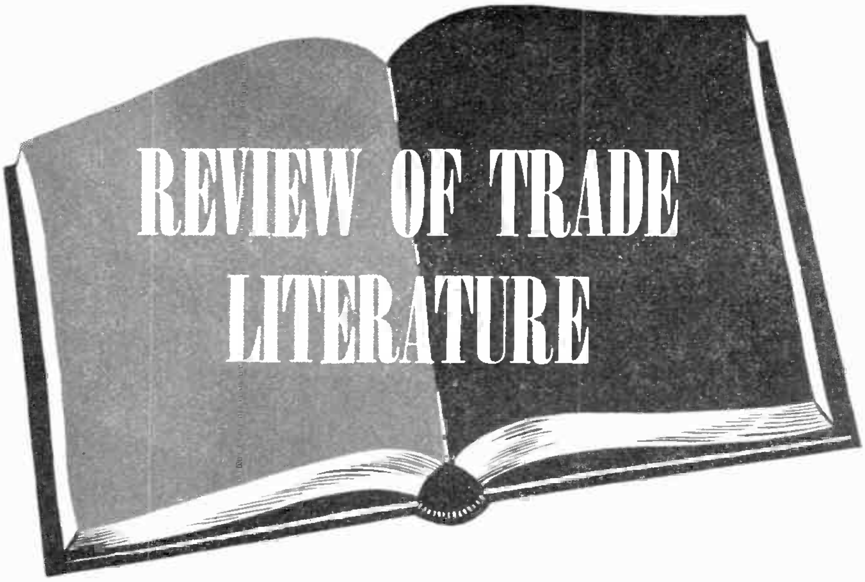
Detailed information can be secured by writing to the Kato Engineering Co., Mankato, Minn.

AMPHENOL TRANSMISSION LINE

Among solid dielectric parallel lines, Amphenol's Twin-Lead Transmission Line is the champion. It carries signals from antenna to FM and Television receivers with minute loss . . . it's tough . . . inexpensive . . .simple to install . . . repels water . . . is unaffected by acids, alkalies and oils because the dielectric is Amphenol Polyethylene. In temperatures as low as —70° F. Twin-Lead Transmissions Line remains flexible and does not become brittle even after continuous aging in sunlight. The 300 ohm Twin-Lead Line can be easily tacked to walls or wood trim or run under windows without special insulation provisions. These qualities mark Amphenol's Twin-Lead Transmission Line as a wire of extraordinary efficiency, life and utility.

For further details write to the American Phenolic Corporation, Chicago 50, Illinois.

REVIEW OF TRADE LITERATURE



WRITE for Ohmite's bulletin No. 127. It contains complete data and list of R M A values, a handy color code and information on the new line of Little Devil resistors. These new resistors are rugged and stable and worthy of the name Ohmite. Address Ohmite Manufacturing Company, 4913 Flournoy Street, Chicago 44, Illinois.

THE NEW SOLAR CAPACITOR catalog, SC-1, has just been released, and lists the complete jobber line of this company's products. The wide variety of capacitors includes the popular "Minicap" tubular dry electrolytic and universal replacement types, as well as the standard metal-can electrolytics. The regular types of paper and mica capacitors are well represented, and the catalog lists eighteen hearing-aid types with a 100-volt D-C rating.

This catalog also announces the new Solar Exam-eter, capable of comprehensive tests on the operation of capacitors. It measures capacitance, leakage current, and insulation resistance, and incorporates a D-C VTVM which reads up to 550 volts in three ranges, and an A-C VTVM covering the range from 10 to 50 volts. The "quick-check" feature immediately detects shorts and opens, and indicates high R-F impedances.

Write Solar Capacitor Sales Corp., 285 Madison Ave., New York 17, N.Y.

The RADIART Vibrator Replacement handbook may be obtained by addressing the RADIART CORP., 3571 W. 62nd St., Cleveland 2, Ohio.

This handbook lists vibrators by set name and model number, manufacturers' part number, and Radiart number, and gives buffer condenser and basing information.

The 40-page booklet also aids you in determining the correct Radiart Replacement Vibrator when the make and model are known as well as when no information regarding the correct type is available from the set itself.

It is a very handy compilation, and the Radiart company will be glad to oblige you with a free copy.

ALLIED RADIO CORP., announces the publication of a new 1946 Buying Guide, "Everything in Radio and Electronics." Included are complete detailed listings of tubes, test instruments, transformers, resistors, condensers, volume controls, switches, tools, wire and cable, batteries, and, in short, everything the serviceman needs to restock shelves depleted during the past years.

All equipment is presented in organized sections with items indexed for easy reference. Public address and intercommunication units are listed for every indoor and outdoor requirement, with ready-to-install systems for a variety of applications. The sound equipment section also includes wide listings of microphones, speakers, and other accessories. For training programs and experimental work, there are a number of kits, manuals, and diagrams. A large technical book section covers leading publications on radio, electronics, and electricity.

This 1946 Buying Guide may be obtained without charge upon request from Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

CLAROSTAT CATALOG No. 46, just issued, lists an exceptional variety of resistors, controls, and resistance devices. There are wire-wound power resistors and glass-insulated flexible resistors; composition-element and wire-wound rheostats and potentiometers; tapped and tapered controls and switches; constant impedance input and output controls and attenuators; tube-type wire-wound resistors, automatic line voltage regulators and replacement line ballasts; power rheostats; and the unique power resistor decade box. A copy of this catalog may be had from any Clarostat jobber, or by writing direct to Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn 2, N. Y.

The STACKPOLE CARBON COMPANY Catalog 1B brings full details and helpful data on welding electrodes, plates, rods, paste, resistance welding tips and similar other products for

→ To Page 30

PA Systems

→ **From Page 9**

system similar to that of a motion picture sound system, using a high frequency unit with a multi-cellular horn and one or more heavy duty low-frequency speakers of the cone type. Smaller high-quality installations can be equipped with a unit giving similar quality of reproduction in a much more compact form. Such a unit is pictured in Fig. 6. Speakers of the type shown are made by Altec-Lansing, Jensen, and Stephens. The reproduction from this type of unit is extremely fine, and will provide restaurants and night clubs with the best possible service. The construction of these speakers combines the high frequency horn with the low frequency cone, the horn throat for the high frequency unit passing through the pole piece of the cone unit.

The placement of speakers is a very important problem, because proper speaker positioning is necessary to reduce feedback and still cover adequately the entire auditorium or grandstand, while at the same time eliminating interference patterns from the various speakers. For halls, it is considered good practice to place a speaker at each side of the stage, directing them in such a fashion that the entire audience is covered. In cases where a balcony must also be covered, it may be advisable to use four speakers, two on each side of the stage, with one speaker of each pair directed upwards to cover the upper seats. The diagram of Fig. 7 shows how this can be accomplished.

For complete coverage of a long

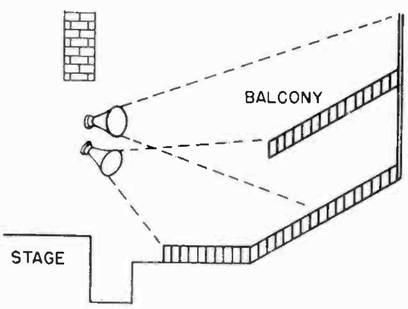


Fig. 7 Arrangement of loudspeakers for the most efficient coverage of orchestra and balcony seats in a theatre with using speakers with wide angles of distribution.

grandstand, horns similar to the one in Fig. 8 can be used. These will give a wide angle of distribution horizontally, with very small vertical distribution. This results in an efficient

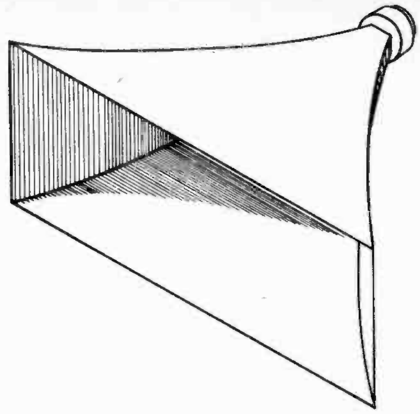


Fig. 8 One form of speaker suitable for sound distribution over a long, low area, such as a grandstand.

installation, and gives optimum coverage.

Care should be taken never to locate speakers so that sound may reach any part of the audience from two speakers when the two speakers are at different distances from the listener. Speakers should never be placed at the stage *and* at the sides or back of an auditorium. This arrangement results in interferences between various speakers, and in most cases is worse than no speakers at all. All the sound heard by any listener should come from one speaker, or at least from speakers located equidistant from the listener.

Transmission Lines

Under this heading, we will consider the type of line that should be used, both from the sound sources to the amplifier, and from the amplifier to the speakers.

For a permanent installation, it is wise to plan on a sufficient number of microphone outlets to take care of some expansion. Speaker lines should be selected with the size of wire sufficiently large to handle the power without undue loss. It should be remembered that a 3 db loss in the speaker line means that one-half of the power is wasted, and that you will need a 40-watt amplifier for the same coverage that could be obtained by the use of a 20-watt amplifier if there were no losses in the line.

Portable installations can be adequately served by the use of a good grade of rubber covered wire, shielded for the inputs, and preferably using wire no smaller than #14 for the speaker leads.

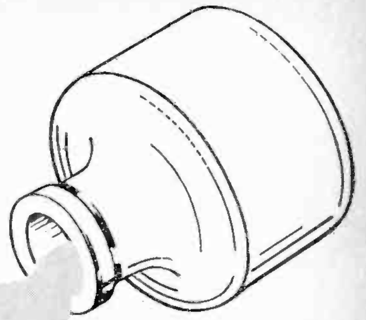
Co-ordination

The complete assembly of a good PA system demands that each component be selected with due consideration to its relation to other components. The use of 15 microphone inputs is an unnecessary refinement in systems of only 20 watts of power, and to use a 50-watt system with the entire output being fed into one 12-inch cone speaker likewise seems illogical. While the application for which the system is to be used is the controlling factor in its design, it is well to remember that the system must function efficiently as a whole, and that inputs, controls, amplifier and speakers must work together as parts of a complete unit. Flexibility is a very important feature of any good system, but it should not be overdone to the extent of having too many controls for the operator to use, or being so complicated that the greatest use can not be obtained from the system.

This discussion of the problems of public address system design may serve to clarify the many questions that come up in such an undertaking. The requirements make necessary a great number of decisions. There are

Fig. 9 Small portable PA system.

components available which will fulfill the needs of any particular installation. It is expected that the average serviceman will have many opportunities to design and install even the largest systems, and it is something to think about, as it is a business that is both interesting and profitable. Complete familiarity with amplifiers, microphones, speakers and controls will make most of the decisions easy, and thus simplify the design of any particular system.



RADIOMEN'S OPINIONS

Dear Sirs:

I have an unusual request to make of you and although I fully realize the difficulties confronting you today I thought possibly an occasional exception might merit consideration.

I am confined in Attica State Prison where I have spent the last seven years and will be here for another year or so before I am released. I am entrusted with the operation and upkeep of the institutional radio that furnishes entertainment to about 1800 sets of headphones, and your magazine "Radio Maintenance" would help me a great deal in my work.

The purpose of this letter is to ask you if you would please consider sending me a complimentary subscription to your magazine Radio Maintenance. I know that it is asking for quite a lot but it would help me a great deal here as well as when I am released to begin my life over again in society. I cannot pay for it now, but I assure you that some day I will show my appreciation for any consideration shown this request.

Sincerely yours,

P. O. Box 149
Attica, N. Y.

Editor's Note: In the interest of the many listeners whose entertainment is dependent on this writer's work, we are pleased to enter a subscription in his name for one year.

Gentlemen:

From a technical viewpoint your magazine is tops! Keep the issues free of too much beginner's material and new merchandise reviews and it will be the choice of many servicemen.

I have just finished reading the February issue and find many of the articles excellent. I especially liked the "Symposium on Test Equipment". This was a very timely and much needed feature.

So much for the orchids! Now for a favor! Is it possible to send me all issues of Volume One and the January issue of Volume Two? If so, hurry them on their way and I will remit whatever the charges may be. I'm sure this requests tells you more than any number of words what I think of your excellent publication.

Sincerely yours,

K. J. JACOBCHICK
West Allis 14, Wisc.

Editor's Note: We were able to send reader Jacobchick copies of the October and January issues of which we have a limited number. We are sorry that we have no other back issues.

Gentlemen:

With Mr. Porter Bennett I heartily agree—every so-called engineer should be compelled to work in a service shop, and he should be given only those sets which are a mechanical mess. Would this teach him the folly of his ways?

We realize very well that it is rare that you will find an expert radio engineer and an expert mechanical engineer in the same man. Perhaps that is the reason we find so many sets that are mechanical messes. If steam engineers and turbine engineers made as many mechanical errors as are made by radio engineers, then industry would be in bad shape.

If radio manufacturers were saving on production costs, there would be at least some excuse for it, but the contrary is true. Why the manufacturers allow their engineers to increase costs so much by their nonsensical designs I have never been able to fathom. Obviously the more simple and easily applied any article is, the less it costs to produce, especially when the manufacturer must use the same methods of application as the repairman, as for example, removing and installing a chassis in its cabinet. When one set requires one hour to remove and another requires ten minutes, it is obvious that the cost of the second is less than the first.

Radio receivers require periodic service. The radio servicemen is the one to render that service. Suppose he should add the cost of removing a poorly designed set from its cabinet, and at the same time explain to his customer the reason for the extra cost. Do you suppose that customer would buy another radio of the same make? He would if he were a fool. Yet, the average customer is not so dumb that he cannot see that the serviceman is having a difficult job with the set. Therefore it is possible for the servicemen to curtail the purchase of a given type of radio that the manufacturer would soon wonder why his sales had decreased to the point of a company loss instead of a profit. Servicemen are beginning to wake up. They have had enough of a mess. Let them become disgusted to the extent that they are ready to do something, and there will be many more unemployed engineers. After 23 years in the service game, I am not surprised that the serviceman is at last beginning to gripe, and I hope

→ To Page 31

If I Were A Serviceman

→ From Page 15

Radio sets are becoming increasingly complicated. Already we see signs of more expensive and more complicated sets coming on the postwar market. To the original broadcast receiver there is now being added the all-wave or short-wave feature, FM, phonograph and the record changer. Soon we shall television in most metropolitan areas, and some already enjoy a telecasting service. Television receivers are really complicated. It will take a lot more knowledge and experience to install and service television sets, and a lot more equipment than even the better service shops have today.

I'd urge you to maintain a good working library of reference books, service manuals, informative house organs, catalogs, and radio publications. Aerovox publishes a monthly *Aerovox Research Worker*. My company spends a lot of money gathering the material for this informative journal. A free subscription is available to each and every one of you. Yon are missing much practical information if you are not on their mailing lists.

In conclusion, let me sum up the few points I have tried to put over:

1. Remember that you're in business to make a PROFIT.

2. Remember that gross profit is only the starting point. It's the *net profit* that really counts.

3. Remember that in arriving at a net profit you must know your actual costs. And *overhead* is a big item in actual costs. Everybody has an overhead. Find out what your overhead is, and see that every job carries part of that burden called overhead.

4. Remember that your main stock in trade is knowledge and experience. Also, you need good test equipment for speedy and positive diagnosis of radio failures. Such equipment soon becomes obsolete or wears out, and must be replaced. In order to have the money ready for new equipment, be sure to charge off that equipment against current jobs.

5. Remember that your customer is entitled to know how you arrive at your estimate or price, but don't be too explicit. Charge list prices for all parts. Only you are entitled to net prices.

6. Remember that you cannot afford to make free calls. Regardless how simple the trouble may prove, you're entitled to payment for time and travel.

7. Remember that you've got to build up and maintain a reputation for honest dealings. Confidence is the main stock in trade.

8. Remember that you cannot afford to use anything less than the best parts available. Those war surplus bargains are a gamble. You cannot afford to gamble with set repairs.

9. Remember that you must keep up with the rapid progress of radio by means of good reading matter. Keep up your working library.

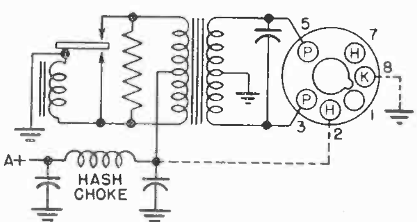
10. Remember that there is more than enough servicing work to be had. You don't have to overcharge to make a good profit. You are in a good line of work. There is a great future ahead. The rest is up to you.

The Radio Service Bench

→ From Page 20

we think it worth passing along.

During the current tube shortage, and even in normal times, many auto radios have been put out of service only because an OZ4 rectifier was not available. Though many auto sets use the gas rectifier, it is very common to find that these sets are also wired for a 6x5. If not, it is a very simple matter to wire such sets



to accommodate the 6x5, which is relatively simple to obtain. Both tubes fit octal sockets, and the pin connections for plates and cathode are the same. It is only necessary to ground pin #7 and install a heater lead for pin #2, as shown in Fig. 2. In some sets it might be necessary to change sockets because of the omission of the heater-pin connections. *(Watch for use of these pins as wiring tie points. Ed.)* If wired as shown, no hash pick-up should be encountered, even if an OZ4 should again be used in the set. The change makes the set interchangeable for either tube, and has been satisfactory in over 100 sets that Mr. Applebaum has converted in this fashion.

An Equalized Amplifier for Magnetic Pickups

→ From Page 17

with the gain-frequency characteristic shown in Fig. 5, curve A being the equalized curve for record reproduction. Curve B is the response obtained when a 10,000-ohm resistor is substituted for the .05-mfd condenser. Curve C is for reference only, being the characteristic of the amplifier with no feedback, and showing the effect of the 400-mmf condenser in reducing high-frequency response. Curve B is suitable for a microphone pre-ampli-

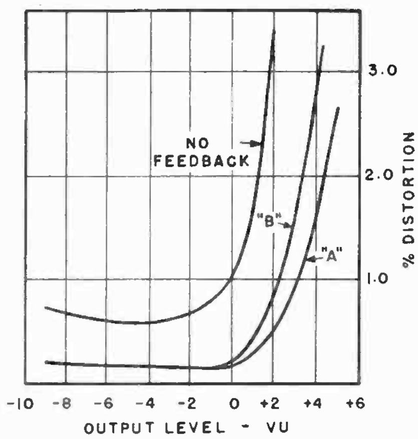


Fig. 6 Distortion curves for complete amplifier.

fier, giving a gain of 28 db. The amplifier is built in a standard sheet metal box 3" x 4" x 5". The chassis is 3/16" bakelite, floating in sponge rubber strips cemented to the sides of the box, and held in position by narrow tin ledges.

The distortion produced by this amplifier was definitely lower than was expected. Facilities were available for measurements at only 400 cps, but, as shown in Fig. 6, the distortion remained below 0.2% up to an output of 0 vu. In both the A and B positions, the distortion was less than 1.0% up to an output of +3 vu. In view of the fact that a commonly-used standard type of microphone pre-amplifier uses two stages, the last stage being a 76 tube operating at 180 volts and has a harmonic content of 1.0% at +2 vu, this miniature device operating with only 67.5-volts plate supply and having only 0.5% distortion at the same output level seems quite remarkable. It does serve to prove that the 1T4, triode-connected, is a useful tube, and should find may unusual applications in portable equipment.

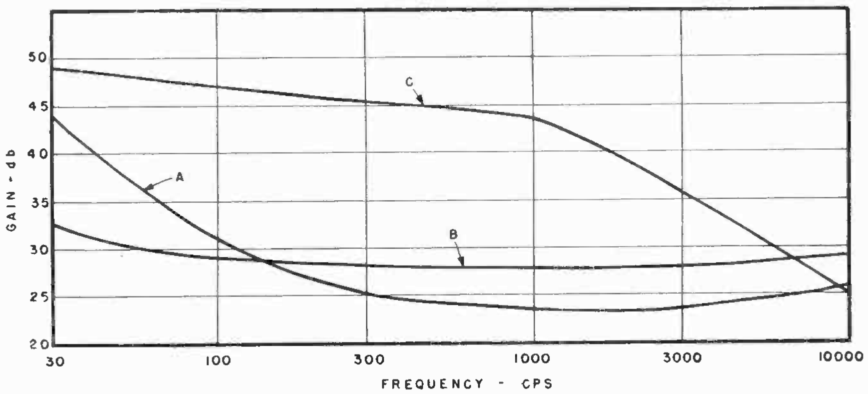


Fig. 5 Frequency response of amplifier under various conditions. Curve A represents equalized condition for phono reproduction; B is response with link on flat; C is response without equalization.

Service Kit

→ From Page 22

open condensers associated with decoupling filters. Figure 2 is a representative circuit. Any one of the condensers here will cause hum and instability if it becomes open.

A very frequent source of oscillations and noise is faulty shielding. Corroded contacts between shield cans and chassis are generally the source of trouble. Although cleaning and tightening cans generally will clear up the difficulty, in some stubborn cases it may be necessary to bond the shield can to the chassis with a piece of braid.

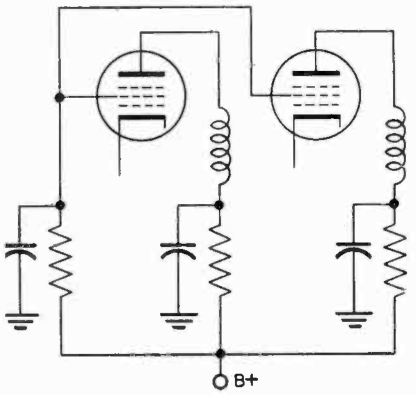


Fig. 2

When trouble-shooting noisy receivers, a stage-by-stage elimination process is of great assistance. Starting from the output stage and working toward the input, short circuit the input of each stage. For example, if shorting the grid of the output stage stops the noise, and shorting the grid of the driver stage does not stop the noise, the noise must originate in the driver stage.

Loose tube elements and erratic contacts on carbon volume controls contribute an annoying type of noise, but usually the trouble is not difficult to locate.

A not infrequent cause of trouble is intermittent contact in condensers. A condenser that intermittently shorts or opens is rather difficult to locate. However, the recommended procedure—and this holds true for any case of intermittent noise—is to allow the receiver to heat thoroughly then tap all suspected components with the handle of a screwdriver or other convenient tool. Many times the defective part is located in a sensitive circuit so that even the slightest tap on any part in the entire receiver will produce the noise. Here again, a stage-by-stage elimination test is of aid. Start with the output stage and work toward the input, successively shorting the grid of each stage and repeating the above test. In extremely stubborn cases, it may be necessary to isolate each stage completely by using an external power supply, signal source, and reproducer. Although signal tracing equipment is ideal, the job may be done by using a similar receiver in good condition, and interchanging stages between the two sets.

This covers the problems of internal noise sufficiently. A reasonable amount of experience, and the curiosity that is normal with the average serviceman should enable him to delve into the problem of a noisy receiver and track down the offending parts. Next month, the problem of noises originating from sources external to the receiver will be discussed. Until then, let us hope that all your noise problems originate within the receiver, and that the above suggestions will aid in solving the difficulty.

Review of Trade Literature

→ From Page 25

industrial use. Of particular interest to many, are the recently developed carbon brazing tips treated with the unique Stackpole "F" treatment. Exhaustive tests prove that these carbons operate satisfactorily at temperatures above red heat, reduce dressing time by as much as two-thirds, and increase life up to five times that of untreated carbon by minimizing oxidation. "F" treated units can readily be fabricated to practically any desired odd or complicated shape.

A copy of the catalog will be sent promptly on request: address Stackpole Carbon Co., St. Mary's, Pa.

The first revised edition of the CANNON ELECTRIC Type "AP" Bulletin has just appeared. This 12-page catalog lists five plugs and three receptacle types which, with the six insert arrangements, make possible 48 different fittings. The series was originally designed for the Signal Corps, but has been extensively used in many types of radio, telephone and sound circuits where a rugged fitting, gasketed for weather resistance, is required. This makes an ideal plug for PA system work.

Besides an extensive information section, there are exploded views of three plugs and one receptacle; dimensional sketches, photos and application views. Dust caps are also illustrated.

Copies of the new bulletin are available at no cost from the Cannon Electric Development Company, 3209 Humboldt Street, Los Angeles 31, California.

Radiomen's Opinions

→ From Page 27

his gripe will become something stronger.

Another point is the dial belt—that small item made from some sort of woven fabric. Examine any book that lists the products of a dial belt manufacturer and note the number of sizes in this small item. An examination of this item will show that the length—when open—of these belts runs from about six to fifteen inches, in 1/32-inch steps. This means that a serviceman must stock nearly 300 belts, merely because of a poor design.

We find parts which have to be changed periodically, buried under a lot more parts that should never need replacement, while other areas of the under-chassis are bare of parts. We find a dial cord that can be changed in ten minutes while the next set of the same general type requires more than an hour to put on a new cord. We find a few sets with parts arranged so that any of them can be reached, while more have important parts buried under a push-button mechanism. There are many sets out of which you can clip one, two, or three fixed condensers without any material difference in the operation of the set.

Have the radio engineers been able to concentrate on one type of speaker plug, or battery plug in portables? No! And it seems that they never will until they are compelled to do so. A plug is such a simple thing, yet it demonstrates the inefficiency. Are there not more different plugs than radio engineers?

Respectfully yours,
JAMES A. ROBINSON.

Electronically Speaking

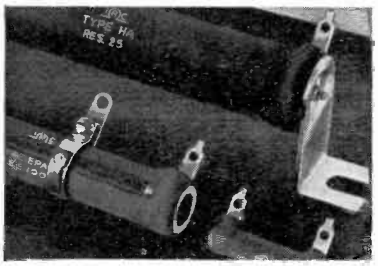
→ From Page 18

sends out radio waves of very high frequency, known as "micro-waves." They speed at 186,000 miles a second to a centrally-located radio beacon in the area which the plane is approaching. The beams are reflected back to the radar equipment, giving a continuous reading of the distance between the beacon, and the plane.

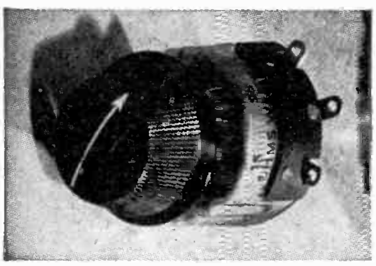
Not too many . . . not too few!

Also at your IRC Distributor's

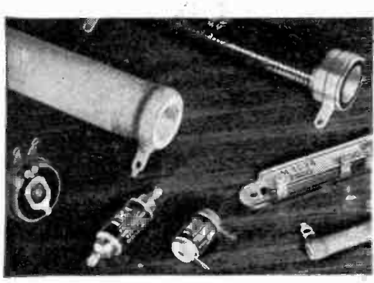
TYPE BT INSULATED METALLIZED and TYPE BW INSULATED WIRE WOUNDS . . . the perfect combination.



POWER WIRE WOUNDS . . . rugged, moisture proof, completely dependable.



POWER RHEOSTATS (above), Precisions, Wire Wound Controls, Bleeders, Non-inductive Wire Wounds, etc. (below)—for many service needs.



The IRC *Century Line* is a commonsense selection of the controls you need for complete service

The controls in the *IRC Century Line* were carefully selected after exhaustive study of IRC sales records and of the requirements of receivers and equipment now in use.

These studies showed that the number of types previously listed could be reduced considerably, yet give adequate coverage. But it also proved that reducing the number of available types to anything *less* than the 100 now comprising the Century Line, would make the service engineer's replacement problem extremely difficult.

On that basis, we established the Century Line—not too many, not too few—but just right to give you properly designed, easily installed controls for the widest variety of replacement needs.

Best of all, it's *not* necessary for you to actually stock all the 100 Century Line types! We recommend you maintain a minimum stock of at least the 18 Type D Controls listed on page 6 of IRC Catalog #50—they'll handle 87% of your replacements—and you can depend upon your IRC distributor for other types, as required.

And don't forget, *only IRC controls* give you such quiet, smooth, dependable performance! . . . because they're the only controls with the famous IRC Metallized Element, the Five Finger Contactor, and the Silent Spiral Connector!

YOUR IRC DISTRIBUTOR is the man to know when you need *any type* of resistor . . . there is an IRC resistance unit for almost every servicing requirement. Ask him for your copy of IRC Service Catalog #50.

FOR BETTER-THAN-STANDARD QUALITY . . . *Standardize on*

PREFERRED FOR PERFORMANCE • IRC • FIXED & VARIABLE RESISTORS •

INTERNATIONAL RESISTANCE CO.

Dept. 28-D 401 N. BROAD ST., PHILA. 8, PA.

***Canadian Licensee:* International Resistance Co., Ltd., Toronto**

•

MAKERS OF MORE TYPES OF RESISTANCE UNITS, IN MORE SHAPES, FOR MORE APPLICATIONS, THAN ANY OTHER MANUFACTURER IN THE WORLD.