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**SERVICE  
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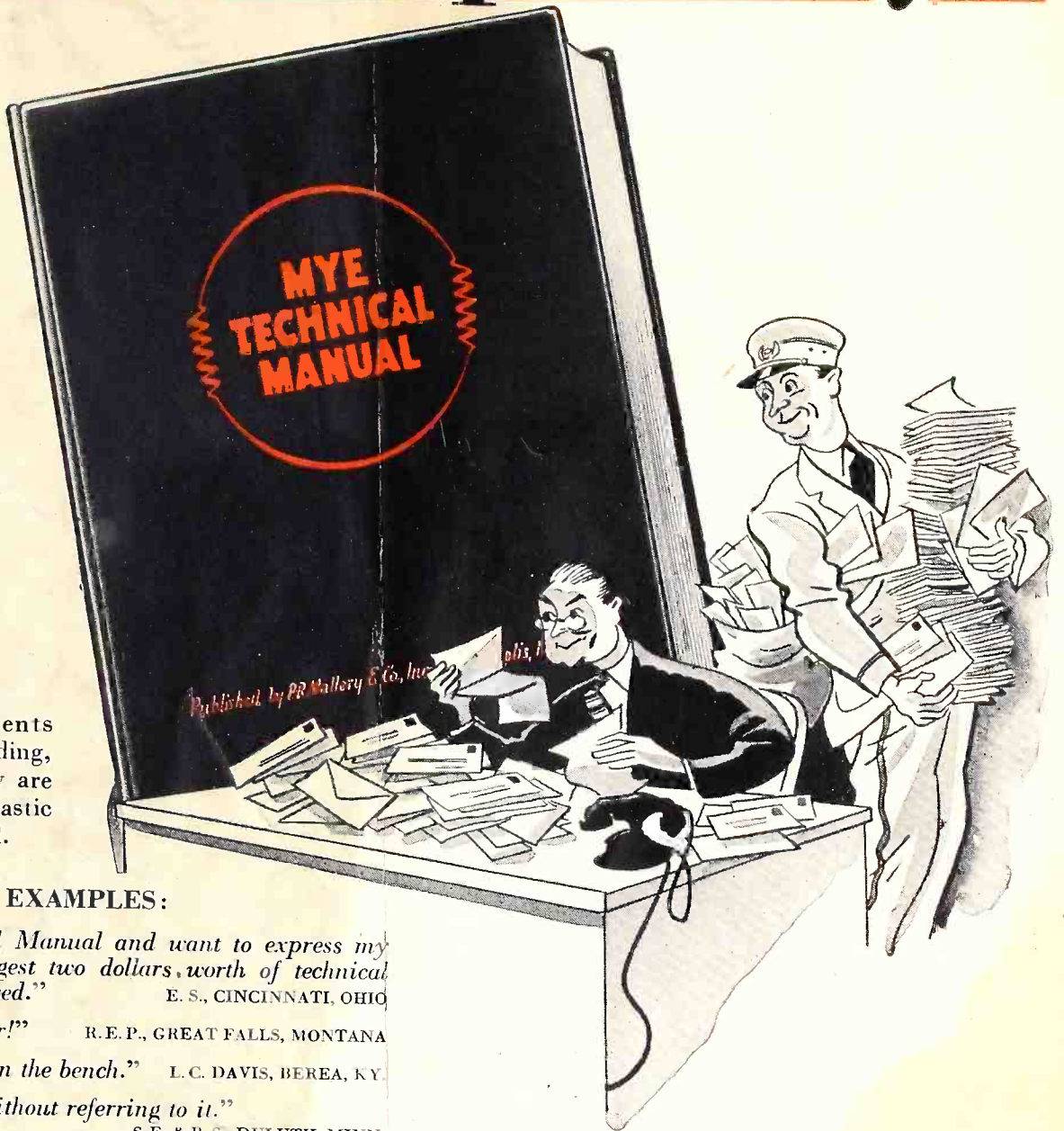


WHERE  
SKILL AND COURAGE COUNT

New Official Signal Corps Cachet. See Page 1

**DECEMBER, 1942**

# What People Say..



Unsolicited compliments make interesting reading, particularly when they are as sincere and enthusiastic as these we've received.

## HERE ARE A FEW EXAMPLES:

"Received the Technical Manual and want to express my appreciation of the biggest two dollars worth of technical information I ever received." E. S., CINCINNATI, OHIO

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The new MYE TECHNICAL MANUAL—2000 copies of it—has found a patriotic service, too . . . in radio training centers of the Army, Navy, and Marine Corps. This 408-page book, handsomely bound in hard cloth covers, beautifully printed, is full of practical information—as useful as a voltmeter, and just as indispensable! Since the supply of Manuals for civilian use is limited, we suggest that you order your copy *today* from your Mallory Distributor.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA  
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# Radio SERVICE-DEALER

SOUNDMAN AND JOBBER

Reg. U. S. Pat. Off.

Vol. 3, No. 12 ★ December 1942

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*The Staff of  
Radio Service-Dealer  
extends to all a  
wish that you have  
A Merry Christmas  
and a  
Happy New Year*

## Cover Picture

(Official Signal Corps Release)

### SIGNAL CORPS CACHET

*This is the first publication release of the new cachet that the Signal Corps is urging manufacturers to display in an effort to obtain enlistments.*

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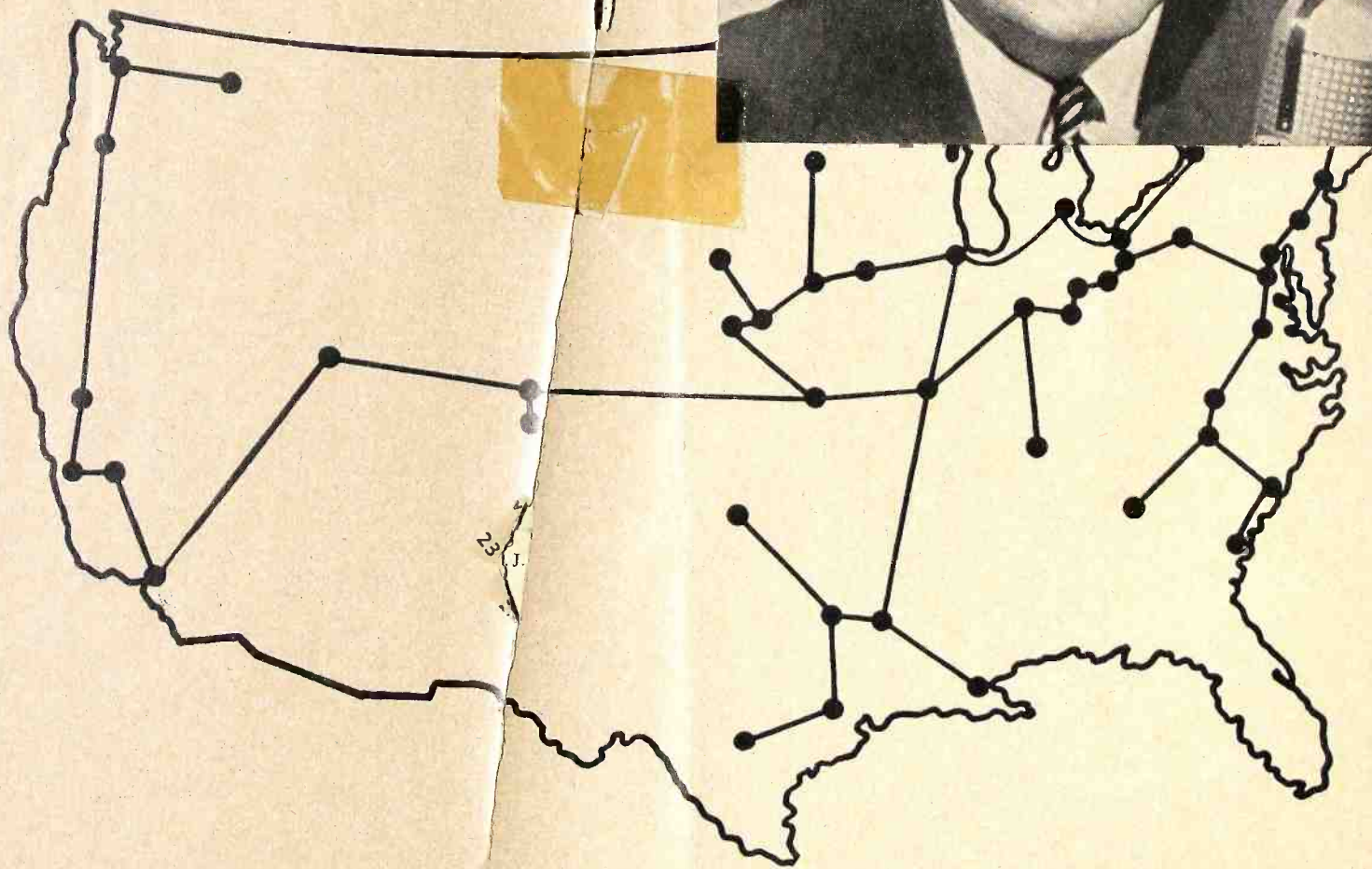
*Executive & Editorial Offices*  
**132 West 43rd St., New York**

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**Radio Service-Dealer, December, 1942**

# G. E. is telling your customers Service over 51 C.B.S.

*The General Electric radio news program, with Frazier Hunt, is explaining to your customers your difficult wartime radio service problems.*



that you **GENERAL**



**ELECTRIC**

Leader in Radio,

P. R. MALLORY & CO., Inc., INDIANAPOLIS, IND.  
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175-A1

Radio Service-Dealer, December, 1942

# about Wartime Radio and 8 FM radio stations

ON DECEMBER 1, the General Electric radio news program, featuring Frazier Hunt, started telling your customers of your wartime radio service problems.

G.E. fully appreciates the difficulties under which radio service men are operating, and is anxious to prevent any public misunderstanding that would reflect on your service business.

Therefore, the G-E radio news program is pointing out over and over that, with so many radio service men now in the armed forces, the task of those still on the job is tremendous and is being met in many cases by day-and-night work. G.E. is explaining that although fewer service men are available to keep the nation's 50,000,000 radio sets working, the hard job

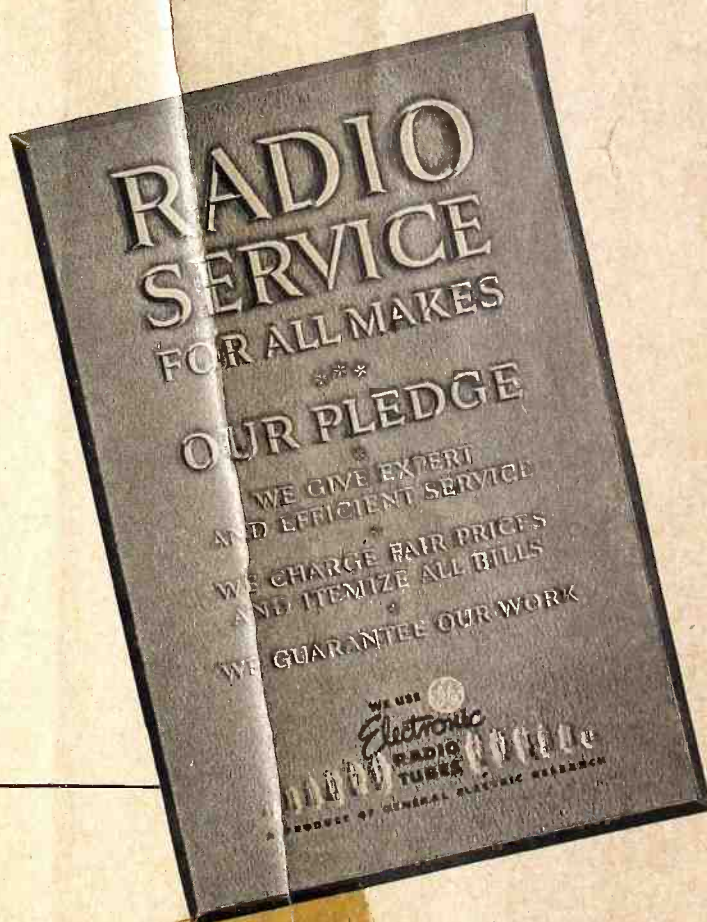
can be done if the public will be just a little patient.

The public is also being reminded that some radio parts are now difficult to get in a hurry. Furthermore, it is being asked to remember that rubber and gasoline rationing are as hard on the service man as on themselves. So radio owners are asked to carry tubes and small sets to you, rather than ask you to go to them.

Above all, G.E. asks the public to understand that you are doing a great job under trying conditions, and that wherever possible G-E electronic tubes and other replacement parts on hand are being rushed to help keep your wartime radio service going. . . . Radio, Television, and Electronics Department, General Electric Company, Schenectady, New York.

## **G.E. IS TELLING YOUR SERVICE CUSTOMERS THAT:**

Thousands of former radio service men are now in the armed forces. Those left in service shops are doing an important job — well! Everything possible is being done to keep America's 50,000,000 radios working. A little customer patience over delays is asked for — and appreciated. Gasoline and rubber are scarce, so please bring tubes and small sets to the service men whenever possible.



Television, and Electronic Research

# editorial....

## The "Victory Line"

• At the request of OPA and WPB the American Standards Association is making a study to determine whether it will be feasible and practical for radio parts manufacturers to produce a "Victory Line" of replacement parts. Such a line would ostensibly take the place of Private Brands which have been nationally advertised, guaranteed and distributed since the radio industry's inception. It is well known that Private Brands are now being diverted to war equipment and are practically inaccessible for civilian radio maintenance because that classification has such a poor priority status.

Before becoming exuberant about the "Victory Line" radio service-dealers and jobbers must weigh *all* the facts. To help you obtain a true picture, let us quote from the ASA's first publicity release (following which our own observations will be given): "Considerable care is being exercised by the ASA committee to make sure that the quality of the standard repair parts chosen will be suitable from the set owners' standpoint . . . sufficient parts of each type will be included . . . to adequately service almost all of the modern home receivers in use today. Tubes are not included in the project.

"In the design of these standard parts the ASA is making every effort to provide units that will be mechanically interchangeable with present parts with a minimum of difficulty.

"Through simplification of the number of varied ranges now in use and the use of multi-purpose units when practicable, the actual number of parts will be held to an absolute minimum in the forthcoming standards . . . for example, some 62 standard volume controls have been proposed to serve as replacements for the thousands of different types used in home radio sets built during the past half dozen years while 9 electrolytic and 11 paper capacitors have been proposed to do a similar job in the capacitor field. Similar simplification and standardization in other radio parts such as transformers, chokes, coils, etc., is also included in the scope of the project now getting under way."

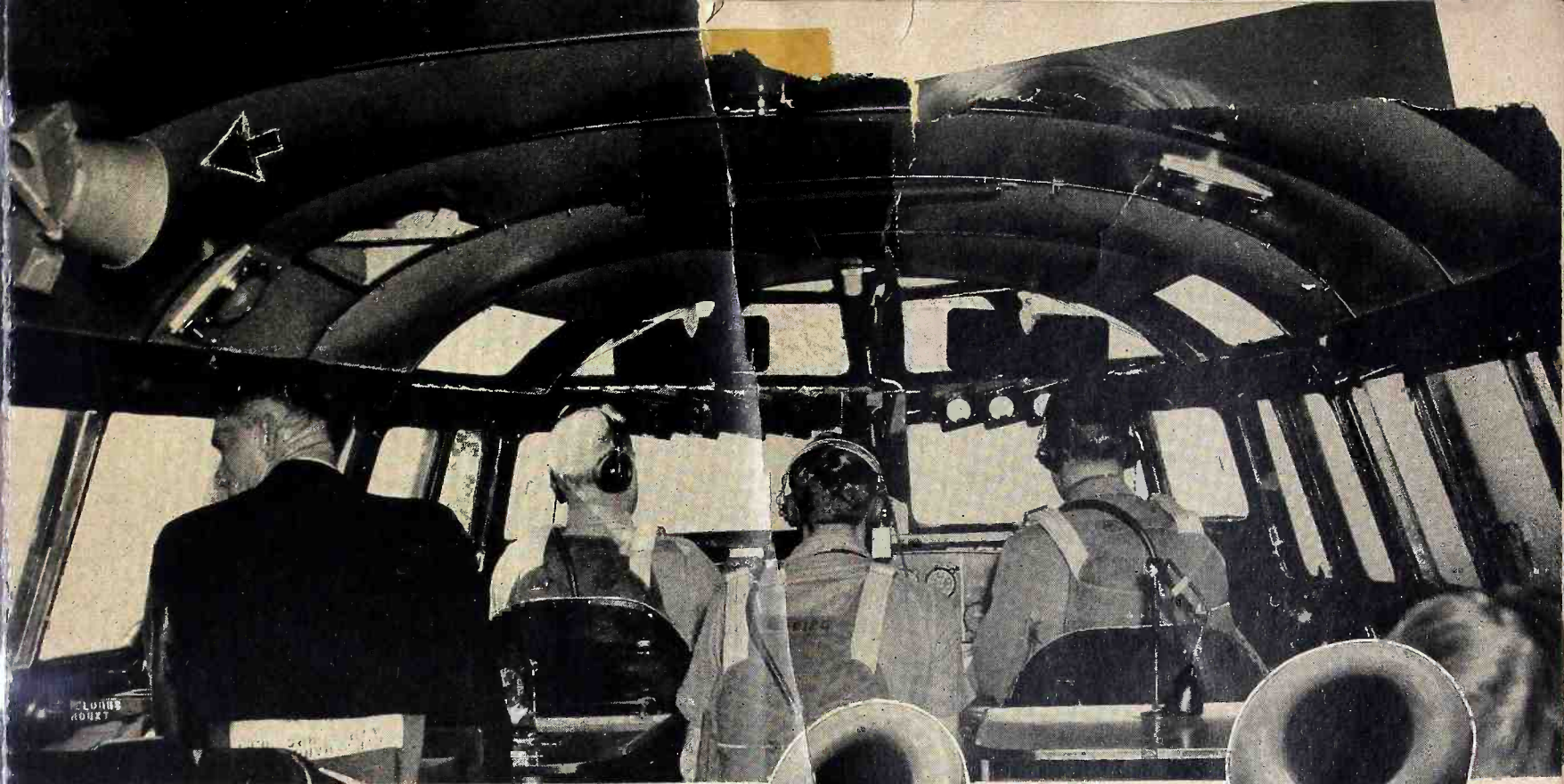
The ASA announcement also bears *this very significant phrase*, "the WPB and OPA are expected to allot materials for manufacture of the standardized parts and to issue limitation and price orders." Brother—do you see the "catch"? That sentence "the OPA and WPB are expected to allot materials, etc." is a joker of the first water. This writer and many parts manufacturers have been given such "anticipated promises" by WPB since the very inception of priorities.

The next catch, in the "Victory" plan, is that radio tube production is excluded entirely. Tube manufacturers frankly admit they are swamped with war orders, their production facilities are tied up for months to come. There are no renewal tubes available for service-dealers. What good will replacement parts be without renewal tubes?

Finally, what about a "Victory Line" that requires new tooling and additional plant facilities, which probably cannot be provided for? And don't forget the new Controlled Materials Plan, which inherently prohibits the production of parts for any civilian use! No, gentlemen, there is but one commonsense answer to the whole radio parts and tube shortage, and it is this: if the WPB and other Washington bureaus stop vacillating and decide that maintenance of civilian radio receivers (at least one in every home) is going to contribute to the war effort, morale or what have you . . . then Washington must simply allocate the necessary metals and materials to parts and tube manufacturers and the latter groups will find the ways and means of producing a short standardized line of useable replacements. We do not favor advertised brands merely because our livelihood is derived from advertising. We do know, from twenty years of practical experience in radio, that so-called "Victory Lines" would probably be sub-standard, impractical to conceive and produce and unsatisfactory in-so-far as proper distribution and substitution for standard brands is concerned.

## Gasoline Rationing

• At the outset of gas rationing we implored OPA to recognize the radio service-dealers' unique status and need for supplementary additional gas. Eventually OPA issued an Order allowing radio repairmen extra gas. Correspondence in our files would indicate that in fact, they are not getting it. Local Ration Boards in big cities have denied service-dealer applicants for "C" cards on the basis that they have suitable regular means of transportation at their disposal to take care of the extra mileage they must cover. Local Ration Boards in suburban and "hick" localities deny extra rations on the premise that the customers must be made to bring in their sets rather than have them picked up, even at centralized pick-up depots, that progressive servicemen have had the foresight to establish. Here is vacillation of the worst order. Either radio maintenance is entitled to recognition for its importance to the public weal, or radio repairing should be designated as "unessential." That point should be decided, but definitely. The average service-dealer is trying to handle six to eight times his normal volume of repair work because eight out of every ten radio servicemen have already entered military service. Give the average service-dealer the same amount of gas he formerly used in the conduct of his business and he will be able to handle the many-times-doubled extra volume of work now forced upon him. That is true expediting and proper use of available manpower.—That is true gas and rubber conservation. What about it OPA? When will practicable standards that lend themselves to the war effort be established? An OPA directive to *all* Ration Boards to grant servicemen a reasonable amount of gasoline will solve the problem once and for all. **SRC**



## RACONS do their bit—

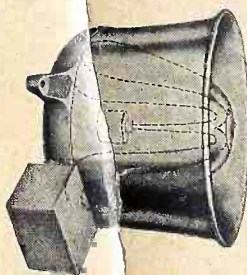
★ Under prime and sub contracts RACON Products contribute to many phases of the war effort. For example, shown here is a RACON Marine Horn Speaker in the cabin of the B-19; and in the other extreme, on the ground a Sperry anti-aircraft detector battery, the three locator horn units of which were made by RACON.

★ If space permitted we'd show how RACONS are used at Army and Air Force training bases—at shipyards—aboard Navy, Coast Guard, Maritime Commission and Transport ships—in factories, and in countless industrial public-address systems.

★ The most important point is this, the quality, efficiency and dependability of RACONS have long been recognized. There's nothing finer. RACONS deliver more energy per watt input. They use RACON's exclusive Waterproof, Weatherproof, Acoustic Material. The elements cannot affect RACON's efficient operation. Use RACON's when planning your next installation. There is a horn, speaker or driving unit for every conceivable purpose. Inquiries are invited—perhaps we can help you in some phase of the war effort. Ask for our free catalog, too.



*Official Photos by U. S. Signal Corps; courtesy of Douglas Aircraft Co. and Sperry Gyroscope Co.*



**MARINE HORN SPEAKERS**



**RACON P. M. HORN UNITS**



**RE-ENTRANT TRUMPETS**

RACON ELECTRIC CO., 52 East 19th St., New York, N. Y.

# RACON

Shown here are but two of the many RACON Speakers and one type of RACON P. M. Horn Unit. The MARINE HORN SPEAKER may be used as a loud-speaker or microphone, comes in several sizes; is approved by the Bur. of Marine Inspection, Dep't. of Commerce. MARINE CONE SPEAKERS are the re-entrant type, suitable for indoor or outdoor use. Stormproofed for all weather conditions. Sizes for 2, 3, 5, 8 and 12 inch speakers. RACON P-M HORN UNITS are available in operating capacities of from 5 to 50 watts.



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famous will keep that now-precious  
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for Replacements . . . and always  
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- FIXED AND VARIABLE  
CERAMIC CAPACITORS
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**CENTRALAB:** Div. of Globe-Union Inc., Milwaukee, Wis.





# CHOOSING A MICROPHONE

by John A. Potts

**W**E hope that no one, in glancing at the title of this article, or at the illustrations of mikes appearing herewith, will be led to believe that there are places where a plentiful variety of microphones is available from which he may select whatever pleases him. Far from it. And because microphones are scarce and limited in variety, it is all the more important that we be sure, before we start looking around, that the type we have in mind is the proper one for the job. Also, because we may not be able to find just what we want, we need to know if some other type, perhaps easier to get, may possibly do the trick as well. We must also consider whether the amplifier we plan to use has sufficient gain and is otherwise adaptable for use with the microphone we intend to use. Therefore some discussion of microphone sensitivity ratings is in order, particularly since these ratings have undergone revisions in recent years.

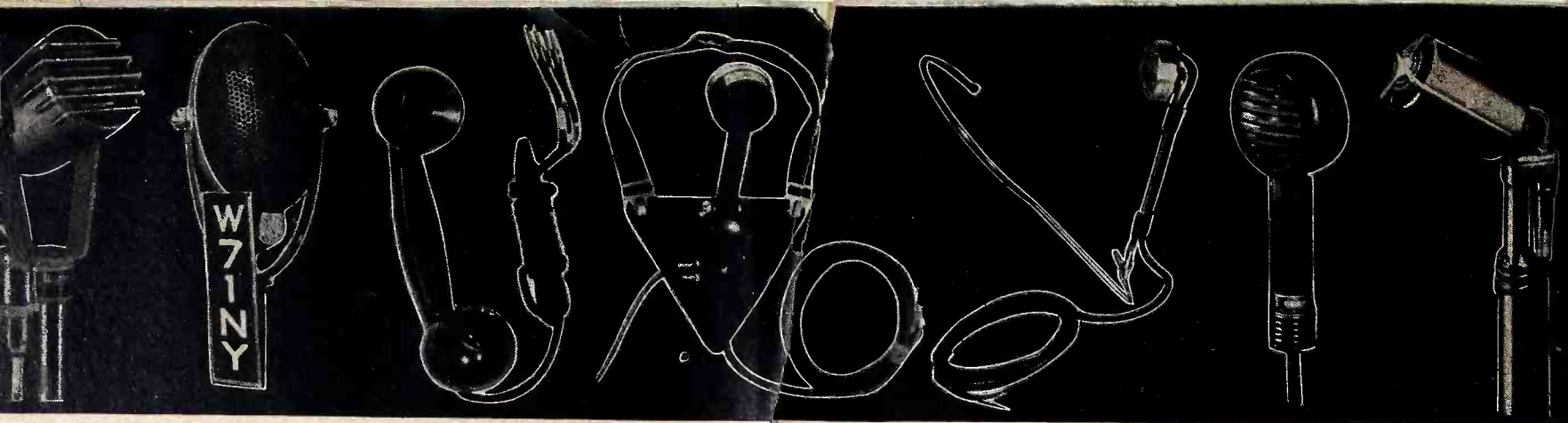
Fundamentally, microphones may be divided into three classifications,

(1), those in which a sound wave acts upon a ribbon or diaphragm placed in an electro-magnetic or electrostatic field and thus causes a variation in the intensity of this electric field and, consequently, of the potential across the output terminals of the device, (2), those in which the sound wave creates a voltage across a crystal of the Rochelle salt variety, due to the phenomenon known as piezo-electricity, (3), those wherein the sound wave causes the resistance of carbon granules to vary, and thus varies the current in a circuit of which the granules form a part. All these types are in common use, but each has its own peculiarities, advantages and limitations.

## Ribbon Mikes

In the first classification we find the ribbon, or velocity, microphone and the moving coil, or dynamic type. In the former, a thin strip of metal is placed between the poles of strong permanent magnets so that its width is in the plane of the electromagnetic field. The dif-

ference between the sound pressure at the front and back of the ribbon causes the ribbon to move and thus varies the electromagnetic field in synchronism with the sound frequency. Because the ribbon must be thin, light, and of low resistance in order to respond freely to high, as well as low, frequencies, it has an extremely low impedance. Therefore a coupling transformer is usually built into the microphone case, stepping up the impedance from a few ohms or less to perhaps 200 ohms or more at the output terminals. The sensitivity of the ribbon microphone is often low in comparison with many other types, but this is counterbalanced by excellent fidelity. In general, this applies to most microphones—the greater the output voltage they supply, for a given sound level, the poorer the fidelity. The ve-



**MICROPHONE TYPES**—(from left to right)—Electro-Voice, Dynamic; Western Electric Experimental Synchronized F-M, Condenser; Universal, Carbon handset; Universal, Magnetic field type; Universal, Military; Shure plastic cased Crystal; Webster, Super Dyme.

locity microphone is excellently adapted for studio work because of its fine fidelity. Likewise it is extremely useful where the microphone must be placed in the same room with loudspeakers, because it is highly directional, especially the cardioid type, so it may be placed at such an angle to the sound waves reflected back toward the microphone that they will not get into the mike and cause acoustic howl. Because there is a transformer in the mike, it must be kept well away from magnetic fields, such as the power transformer in the p.a. amplifier, or any rotating electrical machinery in the vicinity, otherwise hum results. The output level is rated around -74 db below 1 volt per bar (we'll say more about this later on.)

The moving-coil, or dynamic, microphone also operates on the electromagnetic principle. In fact, this type of microphone is quite similar in principle to the ordinary dynamic loudspeaker. A moving coil of aluminum ribbon, attached to a dural diaphragm, is suspended in an electromagnetic field. When sound waves strike the diaphragm, it vibrates, thus causing the moving coil to move in like manner within the electric field. This movement cuts the magnetic lines of force and thus creates a voltage across the moving coil. An impedance-matching transformer, built within the mike housing, steps up the low moving coil impedance to an output value of 200-500 ohms. In some types, this transformer is

omitted and the output terminals connect directly to the moving coil, the impedance of which will be of the order of 20 ohms. This type of microphone delivers a somewhat lower output voltage (when no transformer is built into the mike) than the velocity type with the transformer so that its rating is lower—about -88 db—and therefore an amplifier with higher gain is required. If a coupling transformer is used—and it should be for maximum efficiency—the same precautions regarding the placement of the mike with respect to electromagnetic fields must be observed, as with the velocity type. This type of microphone is responsive to sounds reaching it from all directions, and is accordingly termed “non-directional.” The advantage of a non-directional mike is that a sound source extending over a wide area, such as an orchestra, can be handled by a single mike, or a speaker who has a tendency to meander around the platform may be picked up more easily and uniformly. The disadvantage is that greater care must be exercised in the placement of loudspeakers in order to avoid feedback. This may be overcome by placing the mike in a reflector of some sort—the parabolic type has been used—which will make it directional.

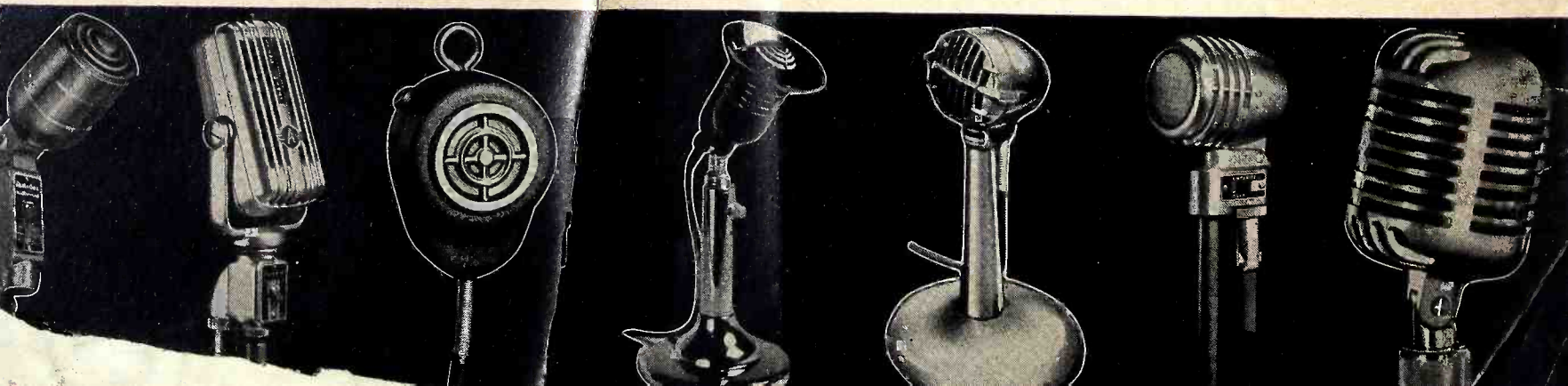
#### Crystal Mikes

Crystal microphones have come into wide popularity, due in part to their sensitivity and simplicity of

operation. No coupling transformer is required, thus the precautions required with electromagnetic types of microphones are unnecessary. Their voltage output is relatively high, ranging up to about -64 db in the sound cell type and the frequency response characteristics are very uniform over a wide range. These mikes are essentially non-directional and are therefore adaptable to the same applications as the moving-coil type of microphone. The “sound-cell” crystal type, consisting usually of several individual crystals connected in series-parallel for maximum voltage output, is representative of the best of this type, insofar as fidelity is concerned. The diaphragm type, in which sound waves striking a diaphragm actuate a drive pin connected to the diaphragm and pressing against a corner of a crystal, which is independently supported within the mike housing at its three remaining corners, in such manner that the crystal is placed under mechanical stress, is the most sensitive type available, ranging up to -46 db. While all crystal mikes are high-impedance types, they may be used if desired, with coupling transformers when it is necessary to match a 200 or 500-ohm line. In such cases, the coupling transformer high-impedance secondary is connected to the crystal output, while the 200 or 500-ohm primary feeds the corresponding input circuit of the amplifier through the

(Continued on page 19)

**MICROPHONE TYPES**—(from left to right)—Electro-Voice, Dynamic; Amperite, Velocity; Electro-Voice, Carbon; RCA-Ribbon-Dynamic; Asstac, Crystal; Amperite, Dynamic; Shure, Cardioid.



The high regard in which IRC Resistors are held by Engineers and Executives of America's leading electronic industries is clearly attested by the voluntary remarks quoted at the right. These are taken from among returns to a nation-wide marketing study recently made by a wholly independent research organization. This survey was completely unbiased, with no company name or product disclosed.

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"Most complete engineering data."

"Most stable as determined by laboratory tests over two-year period."

". . . In my business, Aircraft Electrical Engineering, I always specify IRC."

"Fine people to do business with."

"We handle only one line of resistors and of course that must be the best—namely IRC."

"To us, in the . . . . . Company, the IRC mark on a resistance is the equivalent to a hallmark on sterling."



IRC flies the flag of the Army-Navy Production Award for "high achievement."

# METERING MIRACLES

by L. R. Byron

**Y**ES, miracles can be performed in connection with metering equipment, miracles in the way of saving instruments or in making old and discarded apparatus do the job and do it well. For, despite what the advertising boys have had to say about it, it is still possible for the technical expert to service a radio receiver with the simplest of equipment, provided he is willing to go to a little extra trouble and to use the old noodle. Too many servicemen reach for the soldering iron before stopping to think about what they are doing. I know because I've been one of them! But I reformed one day when looking at the contents of the cash till. It pays to think—to take an extra moment, and to use it wisely.

## The A.C. Meter

As an example of this line of reasoning, take the man who suddenly finds that the a.c. meter he has works all right on the voltmeter ranges but that something has gone kerfloey with the 0-15 or 0-5 a.c. ampere scale. After taking off the panel of his superdooper tester with its thousand and one wires, he wisely decides to let well enough alone in view of the fact the factory is swamped with war orders and meter specialists can't take care of civilian instruments. The a.c. current can be checked by inserting a resistor in series with the load, as in *Fig. 1*. If the set draws one ampere, a suitable value of series resistance is 3 ohms which will give a full scale deflection on an 0-3 volt a.c. meter. There will be a slight voltage drop to the load, but the accuracy of measurement will be sufficient for practical purposes. The current is, of course, the measured voltage di-

vided by the resistance in ohms. The power factor of such a set will be close to unity and the power therefore may be assumed equal to the product of voltage and current.

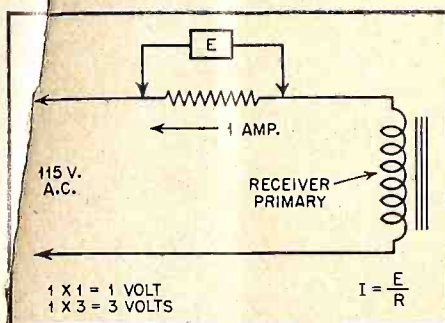
In connection with the accurate measurement of voltage on the plate of a tube having a high resistance plate load, you can use a fancy vacuum tube voltmeter or can measure the plate resistance and plate current as shown in *Fig. 2*. The plate voltage will be the supply voltage less the sum of the voltage drops in the plate load and cathode circuit resistances. The voltage drops are obtained by multiplying the current by the resistance. In the example shown, let us assume the current through the tube is .001 ampere. Then, the drop across the plate load will be  $100,000 \times .001$  or 100 volts. The drop across the cathode resistor will be  $1,000 \times .001$  or 1 volt. Also, let's assume the tube resistance is 100,000 ohms. Then, the sum of the voltage drops, according to Kirchoff's Voltage Law, is the sum of the individual drops and the supply voltage is 201 volts. Now, let's see what happens when we take a 1,000 ohms-per-volt meter and connect it from plate to cathode on the tube. Let's assume the meter resistance is 250,-

000 ohms. Under these conditions the net circuit resistance is about 172,111 ohms and the current is approximately .0011 ampere. The meter then reads 89.9 volts. Knowing the circuit resistance, the voltage drops for the bias resistor and plate load are figured. What's left is available for the plate of the tube. If the voltmeter had a resistance of 20,000 ohms per volt and were set on the 250 volt scale, it would read 99.091 volt. This would be about 9 volts higher than the reading with the 1,000 ohms/volt meter. If a vacuum tube voltmeter were used the reading would be 100 volts on the tube. Assuming an average milliammeter of 50 ohms resistance, the plate voltage reading would be 100 volts. The drop across the meter would be only .05 volt, assuming 1 ma. of current.

## Milliameters

The plate milliammeter can do other jobs as well. Referring to *Fig. 3*, the milliammeter indicates the plate and screen current by reading cathode current which is the sum of the two anode currents. Knowing the value of cathode resistance, the bias on the tube is found. A look at the RCA tube manual shows the plate current is 7 ma. and screen current is 1.7 ma. for a bias of -3 volts. The cathode resistance, therefore, is  $3/7$  plus  $1.7$  or  $3/8.7$  ma. This is 344 ohms approximately and a 350 ohm resistor would do. Now, referring to the tube curve given by the manufacturer, the plate current is about 7.3 ma. which is pretty close to the above figure.

We put a milliammeter in the plate circuit and read this value. Then, tuning the set to resonance with a strong local station, we again check



*Fig. 1.* To check a.c. current a resistor is placed in series with the load.

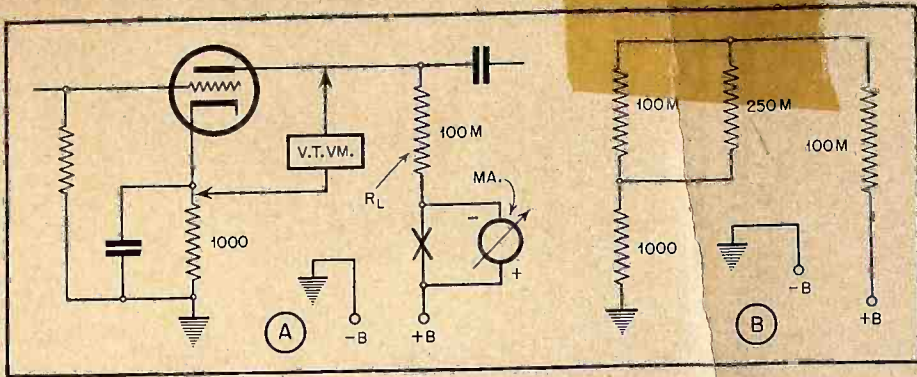


Fig. 2. Measure plate resistance and current to obtain the plate voltage, in a tube having high resistance plate load.

the plate current and find that it is down to 2 ma. Referring to the curve, we see that this value of plate current occurs when the bias on the tube is -10 volts. We now check the cathode current. We find it is 3 ma. Therefore the drop here is  $350 \times .003$  or 1.05 volts and the d.c. voltage across  $C1$  must be  $10 - 1.05$  or about 9 volts. Thus, indirectly, we have measured the bias supplied by the a.v.c. system, without using a vacuum tube voltmeter.

Although it hasn't been used very much in recent years, the simple method of Fig. 4 is useful for checking tubes when a regular tube tester is not on hand. For example, assuming a 6C5 has a plate current of .005 ampere (5 milliamperes) and a bias of 2 volts, by cutting in series with the grid circuit another battery of -1.5 volts we raise the bias to 3.5 volts and the plate current is now down to .0025 (2.5 ma.). The change in plate current divided by the change in grid voltage and multiplied by  $10^6$  (1 million) equals the  $G_m$  or mutual conductance. In this case it would be  $5 - 2.5$  or 2.5 ma. for the plate current change. Then, .0025 divided by 1.5 gives .001666. Multiplying by  $10^6$  or moving the decimal point six places to the right, we get 1,666 mhos as the  $G_m$ . The figure given by the manufacturer in

the tube chart is 2,000 mhos and we would pass the tube as good. The shift in bias should be kept at a low figure to obtain a small shift in plate current. Then, best accuracy will result.

### Computing Voltage Amplification

In order to obtain the voltage amplification of a circuit such as the one in Fig. 4, we could use a vacuum tube voltmeter for the measurement of  $e_1$  and  $e_2$ . The ratio of  $e_2$  to  $e_1$  would be the gain. Thus, if  $e_2$  measured 10 volts and  $e_1$  was 1 volt the gain would be 10 times. Assuming the  $G_m$  is 2,000 mhos, the plate current is .001 ampere (1 ma.) and the plate voltage is 100 volts, what will the gain be for an assumed amplification factor of 20 and a plate load of 100,000 ohms? The following formula can be used:

$$V.A. = \frac{G_m R_p R_L}{10^7 (R_p + R_L)}$$

where V.A. = voltage amplification  
 $G_m$  = mutual conductance in mhos  
 $R_p$  = plate resistance of tube (plate volts/plate current)  
 $R_L$  = load resistance.

Then, substituting in the formula,

$$V.A. = \frac{2,000 \times (100/.001) \times 100,000}{10,000,000 [(100/.001) + 100,000]}$$

$$= \frac{2,000 \times 10^{10} \times 2 \times 10^{13}}{10^7 \times 200,000 \times 2 \times 10^{12}}$$

$$= \frac{1 \times 10^{23}}{1 \times 10^{23}} = 10$$

Or, the following formula can be used:

$$V.A. = \frac{M R_L}{R_L + R_p} = \frac{20 \times 100,000}{100,000 + 100,000} = 10$$

where M = amplification factor of tube, obtained from tube chart.

These calculations need not be performed in most cases but come in handy at times. As a more practical problem to be solved, let's take the case of an ordinary signal generator. For alignment work it is essential that a good signal generator of high accuracy be on hand.

### Aligning Short-Wave Bands

The alignment of a superheterodyne on the broadcast band is comparatively simple but a good job on the short wave bands is not so easy. In the past, many servicemen have not worried too much about short wave alignment because poor reception could always be blamed on "conditions" and they could get away with it. But today many people are interested in short wave and want their receivers to operate properly. Of course, *only American citizens may have such sets*. In order to align the circuits accurately, the average serviceman's generator is not accurate enough to do the job unless it is checked against a standard station. A practical procedure, instead of buying a crystal oscillator, which is expensive, is to zero beat the 1,000 kc. output of the generator against a standard broadcast station. The station is tuned in and the generator, in the unmodulated position, is tuned close to the station frequency. As you get close to the station a heterodyne is heard which is somewhat high pitched. Then you approach the point where a very low frequency sound is heard. Continuing on you hear the low frequency sound again. In between, where no sound or zero beat is obtained, is the correct position of the generator signal.

The 1,000 kc. fundamental will give strong harmonic signals up to about 20,000 kilocycles. From there on you must use 5,000 kc. as the fundamental for good results. Then, in calibrating an F-M receiver, you

(Continued on page 22)

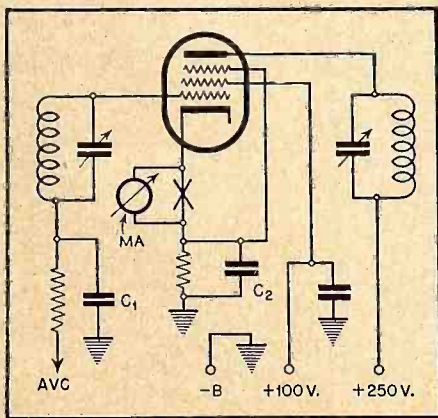


Fig. 3. The millimeter indicates the plate and screen current by means of the cathode current.

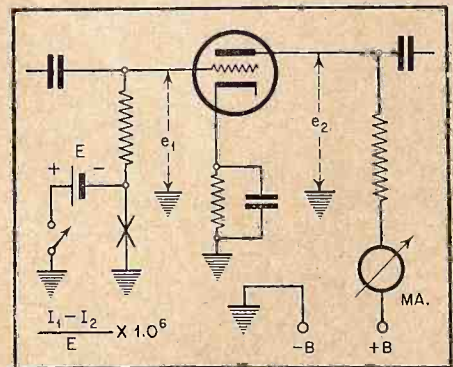


Fig. 4. A simple but old method of testing tubes when a regular tube checker is not available.

# TECHNICAL SERVICE PORTFOLIO

## SECTION XXV

### MODERN P. A. AMPLIFIER DESIGN PRACTICE

**M**ANY servicemen who are competent to repair or adjust even the most complicated radio receivers run into difficulties when working on public-address amplifiers. Yet the circuits in the latter are fundamentally far more simple than many which are encountered in modern radio receivers. Difficulties arise principally, we believe, because the average serviceman just hasn't bothered to familiarize himself with the circuits and peculiarities of high-gain audio amplifiers. Generally such amplifiers are purchased rather than assembled by the user, not so much because they are so difficult to manufacture, (they aren't), but because a professional appearance is essential in any apparatus

which is to be exhibited to the public and this cannot be obtained economically except in quantity production. And because these manufactured amplifiers have given surprisingly reliable service, considering their cost, it hasn't been necessary to learn the details of their design in order to handle the more usual repairs which are likely to be required.

#### Amplifier Modification

Now that it is no longer possible to replace amplifiers which develop serious troubles, because most manufacturers are now engaged solely in war work, a great many amplifiers which would normally be retired from service will require repair. In fact, we are going to have to put back in service many antiquated amplifiers which, in normal times, would be junked. Some will need rebuilding in order to provide sufficient gain for modern microphones or to improve their performance. Modern amplifiers, as we shall see, are much simpler than some of the older types, and we shall often find that it pays to spend a little time and effort in modernizing some of these older instruments. For modern design improvements make possible the greater gain, power output and lower hum level, required to meet present-day needs, and can be effected often with but little difficulty.

Many of the older, relatively low-gain p.a. amplifiers were designed for use with carbon microphones and, when less sensitive mikes were employed, such as the condenser type, made use of pre-amplifiers. Now, at least for p.a. work, the pre-amplifier is a rarity. The input circuits of such low-gain amplifiers were often designed along the lines of audio amplifiers in radio receivers. The volume control was placed right in the input circuit, as shown in *Fig. 1*. With the advent of high-gain tubes and resistance-coupled stages, concurrently with the wider use of less sensitive but better fidelity microphones, the volume control was moved to the second stage input,

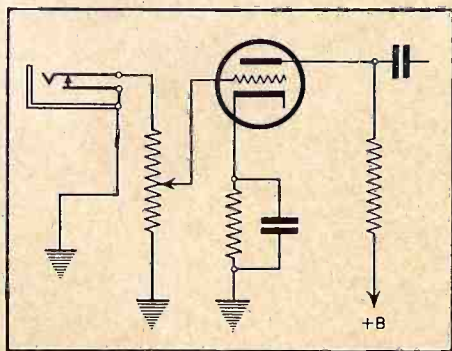


Fig. 1. This type of input circuit is employed only when using phonograph pickups or microphones with very high output.

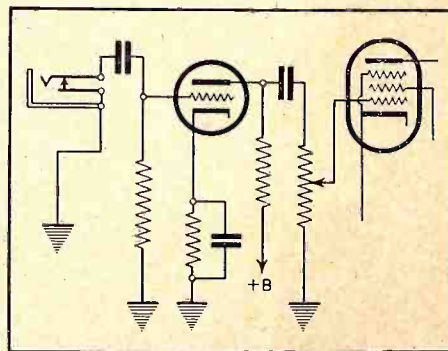


Fig. 2. In high-gain amplifiers for modern microphones, the volume control must be placed in the second stage input.

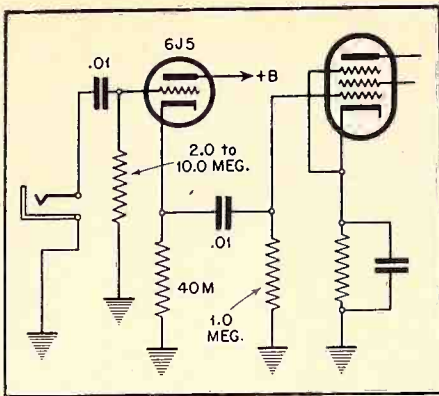


Fig. 3. The cathode follower circuit has many advantages in amplifier circuits, despite the fact that it gives no gain.

as shown in Fig. 2. This change was made necessary because the extremely high overall gain of the amplifier caused great amplification of slight defects in the volume control when it was placed in the input stage. Even a new control would seem to be extremely noisy when being adjusted. Placed in the second stage input, the gain of the first tube was devoted simply to amplifying the output of the microphone, while the amplification of volume control noises was reduced by an amount equal to the gain of the first stage.

In both Figs. 1 and 2, the input circuits are decidedly sensitive; therefore circuit-closing jacks are shown. These jacks serve to ground the input circuit when the mike plug is removed. If this were not done, considerable hum pickup might result unless the input jack were carefully shielded. Although triodes are shown in these two figures, a pentode of the single-ended type such as the 6SJ7 is now almost universally used. The single-ended type, rather than a pentode with a grid-cap, is selected because it is then possible to keep all input wiring beneath the chassis, reducing lead length and simplifying shielding of the input circuit.

Triode resistance-coupled stages have a disadvantage in that, in high-gain circuits, the effective input capacitance is increased by an amount approximately equal to the static input capacity multiplied by the stage gain. This is of little consequence in input stages which normally have high shunt capacity as a result of the microphone and its shielded cable, when the volume control is in the second stage, but will cause severe high-frequency attenuation

when the volume control is in the input stage and adjusted below maximum setting. Then the portion of the resistance between the moving arm and ground forms the second section of a resistance-capacity filter which reduces the high-frequency output. This effect, in interstage triode amplifiers, acts in the same way.

### Cathode Follower Circuits

One method of eliminating the capacity effect of triode high-gain amplifiers is to use a cathode follower stage, such as is shown in Fig. 3. Although this is shown as an input stage, it is really seldom used other than as an interstage amplifier. Since the gain of such a stage is less than 1, the effective input capacitance is not increased, and because of the very low effective impedance of the cathode-loaded stage, the input capacitance of the following stage is reduced well below what it would otherwise be. This type of circuit, used as a coupling medium between high-gain stages of any resistance-coupled type, will improve the high-frequency response of amplifiers of more usual design.

Most commercial p.a. amplifiers are equipped with two or more input stages so that more than one microphone may be used, either simultaneously or separately. Such an input design is illustrated in Fig. 4. One defect of previous designs,

whereby adjusting the gain of one input circuit often affected all others, is greatly minimized in this design. Note that an 0.5 meg. resistor isolates each of the individual volume controls from the master volume controls in the second tube. Thus there is effectively 1 megohm in series with each of the individual controls insofar as their effect on each other is concerned, so that the adjustment of any one control does not greatly change the resistance load on any other control. Whatever change does occur is greater when one control is at or near maximum setting while the other is adjusted near minimum.

In Fig. 4, note the absence of cathode resistors in the input stages. Here the designers have borrowed an innovation from the set field where this type of circuit has come into wide use. Ordinarily the cathode resistor is employed to make the grid bias negative with respect to the cathode. Fundamentally this is necessary to prevent the grid from going positive, and thus drawing grid current, over the positive half-cycle of the input signal swing. The positive grid potential, and consequent grid current, is objectionable in that it places an unequal load on the signal source over different portions of the signal cycle and thus causes distortion. In this circuit, this difficulty is reduced to negligible proportions by using an extremely high resistance input circuit. Thus,

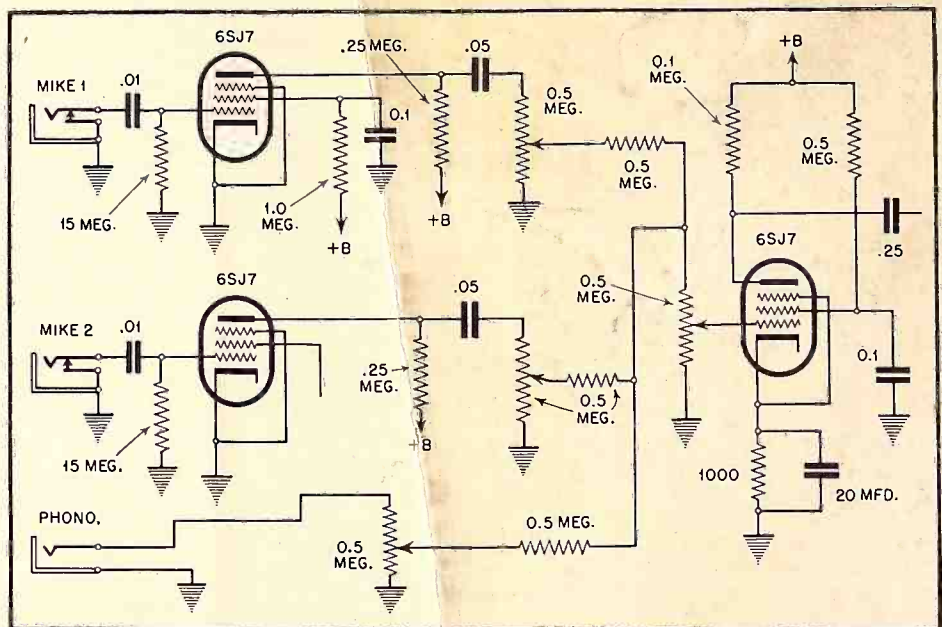


Fig. 4. This type of multi-input mixing circuit is employed in many p.a. amplifiers.

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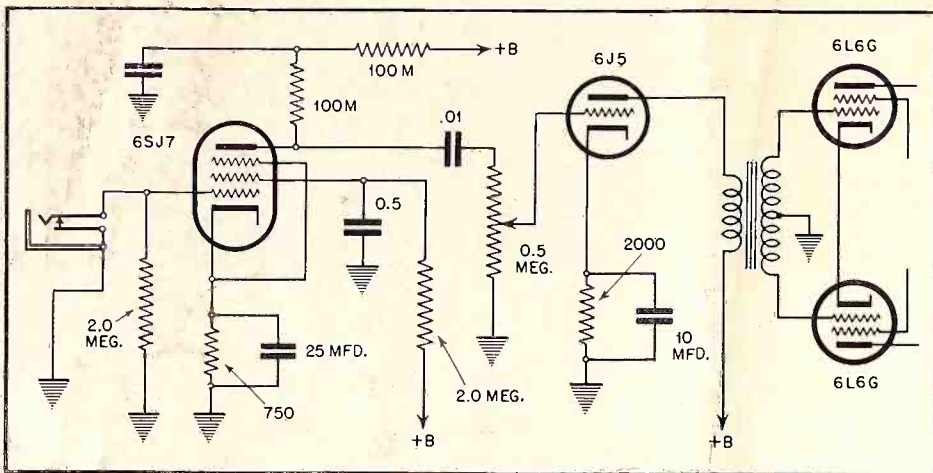


Fig. 5. Simple high-gain amplifier circuits such as this are reliable and widely used.

though the grid can and will go positive over the positive half-cycle of the input signal, it can draw but little current due to the high resistance in its input circuit. Consequently there can be but little loading, and therefore little distortion, introduced. And, the circuit is simplified by the elimination of a resistor and its associated bypass condenser. The input blocking condenser must be added, of course, to prevent a low-resistance mike from forming a path for grid current, which would defeat the purpose of the high resistance in the grid circuit.

The lowest input circuit in Fig. 4 is utilized for phonograph pickup work. Since the output of the average crystal pickup is from 0.8 to 2.0 volts at 1000 cycles when using a record cut at an average level, there is no need for the extra gain of the first high-gain input stage. Consequently, this input circuit con-

nnects to the second stage. Because the amplification will not be very great from this point on, there is also no need to ground the input circuit when the phonograph pickup is not connected. Therefore an open-circuit jack is used.

### Conventional High-gain Circuits

A more conventional high-gain input stage, followed by a transformer-coupled triode stage, is illustrated in Fig. 5. The first 100,000-ohm resistor in the plate circuit of the 6SJ7, with its associated 0.5-mfd bypass condenser, forms a resistance-capacity filter to provide the extra hum reduction required in the output of the first stage. The cathode is bypassed in the usual manner, permitting the use of a lower resistance input grid leak. In this connection, it should be remembered that crystal mikes require a minimum of at least 2 megohms in the input grid circuit, to avoid excessive loading and con-

sequent reduction of low-frequency response.

In Fig. 5, the 6J5 is transformer-coupled to the output 6L6G's. Fig. 6 shows an alternative method of coupling, using a very satisfactory phase inverter circuit. The signal voltage is developed across the 20,000-ohm cathode resistor and the plate resistor of the same value. Since these load resistors are the same, the resulting signal voltage is the same across each. Because the cathode is always most positive at the instant the plate is most negative, the phase of the signal voltages across each is opposite to that of the other. This circuit is degenerative because the cathode resistance is un-bypassed, and the amplification is less than 1 (about 0.8) across each resistance. Actually this results in a stage gain of 1.6, from grid to

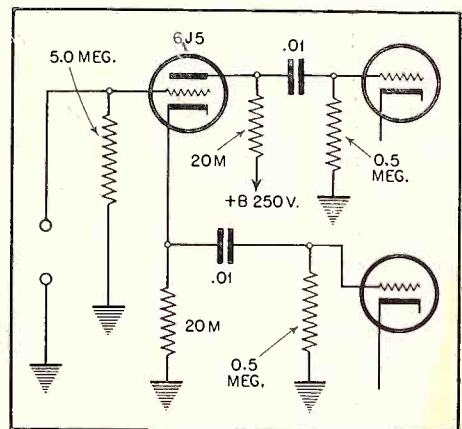


Fig. 6. A phase inverter of this design operates properly with any type of tube and does not get out of balance due to changes in tube characteristics.

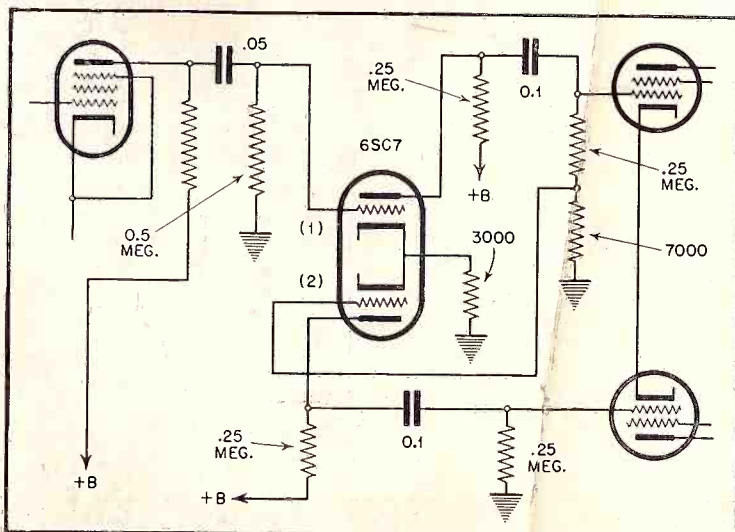


Fig. 7. A tone control, even of the simple type shown, is effective.

grid of the output tubes. This is very slight, of course, but this short-coming is compensated for by its simplicity, reliability and excellent fidelity characteristics.

### Phase Inversion Circuit

Where the amplifier design is such that the number of tubes must be kept at a minimum, the phase inverter stage shown in Fig. 7 may be used. This circuit provides a gain of about 36 in each section of the 6SC7. The upper section, as shown, is fed by the output of the preceding stage and is coupled to one of the push-pull output tube grids. The grid return is made through a 7000-ohm resistor in series with the 0.25-meg. grid resistor. The signal volt-

age developed across the junction of these two resistors is 7000/257000th (about 1/36th) of the total grid voltage applied to the upper tube grid. When this signal voltage is amplified 36 times by the remaining section of the 6SC7, we see that the resulting signal voltage applied to the lower output tube grid is the same as that for the upper tube grid. However, the phase is reversed so push-pull operation of the output tubes is obtained. This circuit is not as good as the preceding one, with respect to uniformity of performance, since the analysis shows that proper operation depends upon the gain of the tube remaining constant and at a fixed value, while the preceding circuit operates properly no matter how much the gain varies. However, the high gain of the circuit of Fig. 7 has made it a favorite and, practically speaking, a surprising amount of unbalance due to variation in gain is not detectable by ear.

Tone control is usually incorporated in the input to the last stage. A suitable circuit which will provide considerable reduction in high-frequency response is shown in Fig. 8.

### Resistance-Capacitance Filtering

One innovation which is coming into quite general use, and which offers a welcome saving in weight of portable or semi-portable p.a. amplifiers is the substitution of resistance-capacitance filtering in the power supply for the more usual choke-and-condenser combination. A typical arrangement of this type is shown in Fig. 9. Note that the output tube plates are fed directly from the start of the filter circuit, thus avoiding the high voltage drop which would otherwise result if the connection of the output transformer were made after the 2000-ohm filter resistor. The only filtration for the output plates is that provided by the 16-mfd condenser from rectifier filament to ground. This type of circuit is practical only with push-pull output tubes, because the hum voltage applied to the output tubes is opposite in phase and tends to cancel out. Perfect cancellation is not obtained, however, because no two output tubes are identical. Some hum always remains, but this is reduced because the output voltage is stepped down by the output transformer. Looking at it another way, the signal voltage is always greatest at the output tube plates; therefore the ra-

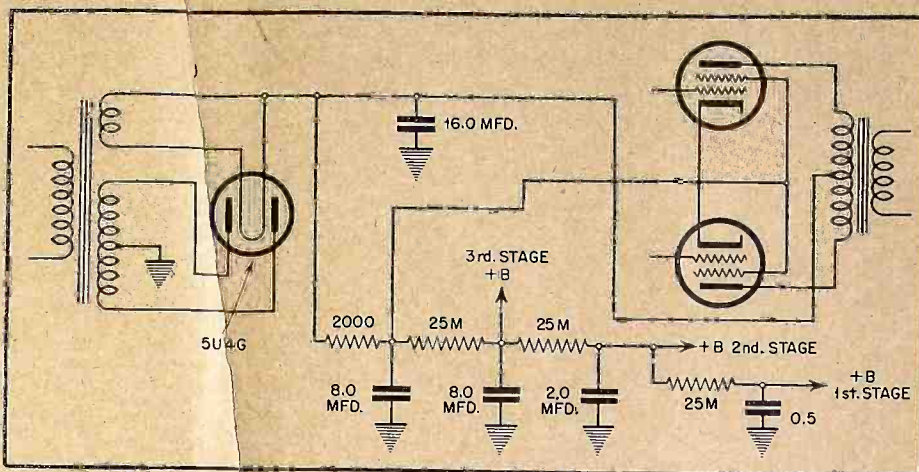


Fig. 9. Chokes are supplanted by resistors in the filter circuits of this power supply, thus saving weight and space.

tio of the signal voltage to the hum voltage will be greatest when whatever hum is introduced arrives in the output plate circuit. The hum level in any p.a. system is always expressed as a ratio of maximum signal to hum, because the hum will then be blanketed by the signal.

### A.C.-D.C. Circuits

Often it is desirable to operate a p.a. amplifier from either a 6-volt d.c. source or from 115 volts a.c. An amplifier which is designed to operate from either of these sources is shown in schematic form in Fig. 10. As illustrated, a motor-generator supplies power for 6-volt operation, while the conventional power supply is available for 115-volt a.c. supply. This amplifier is the Lafayette Model 458 DeLuxe Mobile type. The rated power output is 30 watts; the gain of the microphone channels is given as 130 db, and of the phonograph channels as 90 db.

In Fig. 10, the two 6J7 tubes serve as individual first-stage amplifiers for the two microphone inputs. The mixing of these two inputs (and of the phono input which is joined to one of the microphone first-stage output channels) is accomplished electronically by means of the 6C8G dual triode. Note that the top 6J7 is coupled to one grid of the 6C8G while the lower 6J7, along with the phono section, joins to the remaining 6C8G grid. The 0.25 megohm resistor in series with the phono volume control serves to minimize the reaction on the mike control which would otherwise result when this control is adjusted, or vice versa.

The plates of the 6C8G electronic mixer are joined in parallel, and are

coupled by means of the 10,000-ohm load resistor to one grid of the next 6C8G, which is used as a phase inverter. The 5-megohm control in series with the 0.1 mfd condenser, shunted across the .001 mfd condenser in this coupling circuit forms a treble boosting device. When the moving arm of the 5-megohm potentiometer is so adjusted that all the resistance is in the circuit, the high frequencies are by-passed around this potentiometer, while the low frequencies are attenuated. Thus the high frequencies reach the phase inverter grid with but little attenuation and are consequently stronger in proportion to the lower frequencies than they otherwise would be. So treble emphasis is thus obtained. The 0.25 megohm control, to which the 0.1 bypass is connected, forms a conventional bass control, which emphasizes the bass by attenuating the treble.

The operation of the phase inverter in this circuit is similar to that described before, and illustrated in Fig. 7. Since the plate load in the

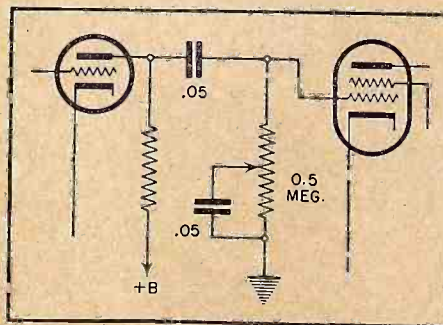


Fig. 8. This phase inverter circuit gives considerable gain as well as phase inversion.

circuit of Fig. 10 is 0.1 meg while that in Fig. 7 is 0.25 meg, there is less gain in the circuit now under discussion. Thus we find that the divider circuit in the 6E6 input grid is here composed of 0.25 meg in series with 10,000 ohms, instead of 7,000 ohms, as in Fig. 7. The gain of this circuit is thus estimated at 26.

The high power output obtained with this compact amplifier is secured by using a Class B output stage, consisting of two 6Y7G's. For mobile applications, the slight additional distortion which results when Class B operation is employed is more than compensated for by the high efficiency of this form of power amplification.

### Eliminating Hum

In using any high gain amplifier, one of the most frequent causes of unsatisfactory operation is excessive hum. In most cases, this trouble is not caused by any fault in the amplifier design, but rather to improper or careless use of the mike or its associated cable and coupling medium. It is absolutely essential that every point between the grid of the first

tube in the amplifier and the microphone itself be completely shielded. With crystal and other non-magnetic types of microphones, this is not difficult. We must make sure that a shielded plug is used, that the microphone cable shield is continuous, with no bare spots or breaks, and that it connects to the ground of the amplifier chassis. Grounding all along the line is important. Sometimes it is found that a reduction in hum is obtained when the a.c. power plug for the amplifier is reversed in the wall connection. There are times when an external ground, connected to the amplifier, reduces hum; sometimes it makes it worse. If there is no bottom cover on the amplifier, hum pickup may result; likewise if the input tube grids are unshielded.

With magnetic types of microphones, or with other types if a coupling transformer is used, it is essential to keep the microphone and its coupling transformer well away from the amplifier, particularly from the power transformer. With very sensitive amplifiers, hum pickup will result due to electromagnetic coupling even though the coupling transformer and power transformer in

the amplifier are several feet apart. Usually, though, the mike or transformer may be turned in such position that minimum coupling, and consequently minimum hum, results. Of course, nearby electrical machinery of any type creating an external field will likewise induce hum in the manner just described.

Most amplifiers are equipped with many taps on the output transformer secondary, so that a variety of output impedances are available. Sometimes it is a problem to decide just which ones to use, when it is possible to match the impedances by connecting voice coils in series or in parallel, or by selecting any pair of a variety of taps on the coupling transformer associated with the speaker. For long lines, say from 50 to 500 feet, it is fairly standard to use a 200-ohm or 500-ohm line. In such cases, the output tap on the amplifier is connected to the corresponding input tap on the speaker transformer. For short lines, the speaker voice coil may connect directly to the output transformer secondary of the amplifier. If the line is long, and the speaker voice

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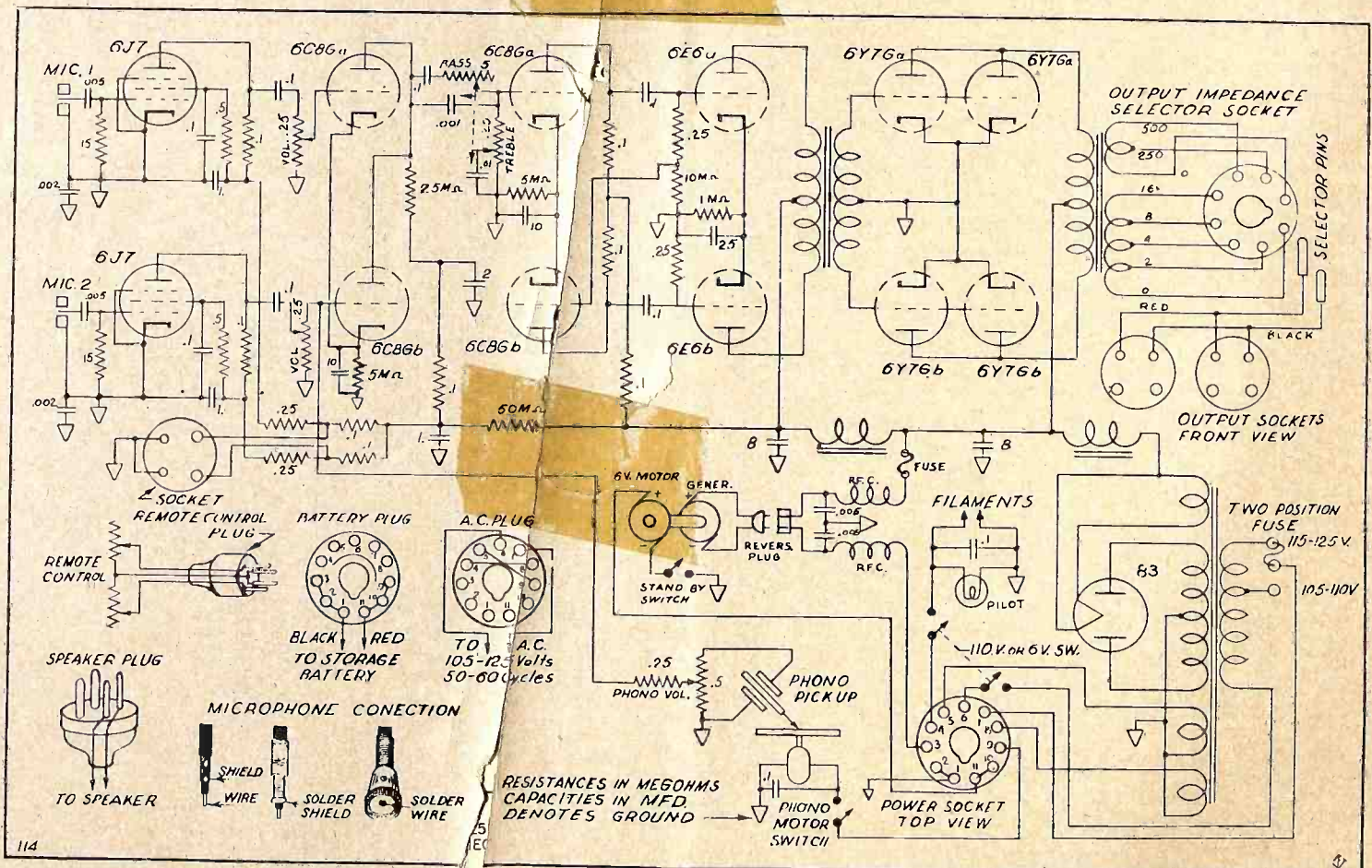


Fig. 10. A complete schematic of the Lafayette 30 watt Type 458 Mobile Amplifier.

## CHOOSING A MICROPHONE

(Continued from page 8)

transmission line. Such a line may be useful when it is necessary to avoid stray pickup in strong electric fields, which are hard to shield against when a high-impedance line is used, as would otherwise be required in connection with the crystal mike.

### Condenser Mikes

Condenser mikes are not often used in field radio work nowadays, partly because of their low sensitivity in comparison with other present-day high-impedance microphones, and partly because of the precautions which are necessary in their handling and application. In the condenser mike, an extremely light dural diaphragm is placed close to, and insulated from, a back plate of substantially the same shape and physical dimensions. Thus these two plates form a condenser. To the diaphragm is applied a polarizing potential, often as high as 500 volts. When sound waves strike the diaphragm they cause it to vibrate, thus varying the capacity between the diaphragm and the back plate. This variation in capacity varies the voltage across a resistor placed in series with the polarizing voltage source, by varying the electric charge on the condenser. The varying voltage across the resistor is applied to the input circuit of a high-gain amplifier.

Because of its extremely high impedance and relatively low sensitivity, it is necessary to use a pre-amplifier in conjunction with condenser mikes. Often the pre-amplifier is built right into the microphone housing. This is desirable, because the capacitance of the leads must be kept at a minimum, otherwise the sensitivity of the mike will suffer. After the pre-amplifier raises the mike voltage appreciably, the output signal is fed to the main amplifier. Although the condenser mike is highly desirable because of its excellent fidelity, the complications of the polarizing voltage source, which must be either pure d.c. or from an extremely well filtered power supply, plus the need for a pre-amplifier, have limited its applications to studio work and to special work in the sound measurement field.

### Velotron Mikes

One type of mike which has been widely used is a combination of rib-

bon and condenser mike, in which a charged and insulated plate is employed in conjunction with thin strips of dural which serve to vary the electrostatic field when actuated upon by sound waves. This mike has many of the advantages of the condenser type plus considerably greater sensitivity. Two types are available; one which requires a polarizing voltage supply and another which does not. This variety of microphone is known as the Velotron. Because of its high sensitivity, less gain is required in the amplifier and the polarizing voltage, if re-

is determined from the formula  

$$\text{Microphone rating in db} = 20 \log_{10} E_o/1 \text{ volt per bar}$$
 where  $E_o$  is the open-circuit output voltage.

We might digress for a moment to tell what is meant by "open-circuit" output voltage. This is the voltage across the microphone output terminals, when it is connected to no load. That is, as measured with a high-input impedance device, such as a vacuum tube voltmeter. If there is a transformer built into the mike housing, this is the voltage across the transformer terminals, not across the mike element. Usually, if

TABLE I.

Type of Microphone	DB Rating	Impedance (ohms)
Velocity (P.A. Types)	-56 to -70	200-2000
Velocity (Broadcast)	-74 to -100	250
Dynamic	-88	20
Crystal	-46 to -86	*High
Carbon	-40 to -55	100-400 ohms

\*Over 150,000 ohms at 400 cycles

quired, need not be so completely filtered. These mikes are extremely directional and may be operated within a few feet of the reproducing speaker without feedback, provided care is taken to put the mike at such an angle with respect to the loudspeaker that no sound waves impinge directly upon the mike.

### Rating Mikes—the Bar

Microphones are rated on their open-circuit output voltage for a given sound pressure input. Sound pressure is expressed in terms of dynes per square centimeter, and a sound pressure of one dyne per square centimeter is conveniently designated as a bar. A sound pressure of one bar is equivalent to that produced when a person speaks into a microphone at a normal conversational level with the microphone about 10 inches from the speaker's mouth. The reference level upon which most microphone ratings are based is one volt per bar, which means that a microphone which delivers an output of one volt when spoken into at a normal conversational level with the mike 10 inches from the speaker would have a rating of 0 db. Actually, no microphone will deliver an output of 1 volt under such conditions, consequently the rating is always less the 0 db. In general, the voltage output will be of the order of 1 millivolt, which is equivalent to -60db. This db rating

there are taps on the transformer, the output rating is specified as the open-circuit voltage across a 250-ohm line, if the impedance happens to be this value across the taps under consideration. When the mike is actually connected to a properly terminated line, the output voltage will be just one-half, or 6 db less, than the open-circuit voltage. In the case of crystal and other high impedance mikes, or of low impedance mikes working into grid circuits directly, the output voltage will be the same as the open-circuit voltage and consequently the rating will apply directly.

Some microphones are rated on a basis of a 10-bar reference level. This rating may be converted to the more usual 1 bar level by subtracting 20 db from the 10-bar rating. Thus a mike rated at -70 db for a 10-bar reference level would have a sensitivity of -90 db for a 1-bar reference level. It is desirable to make this conversion in every case, otherwise it will lead to difficulties when attempting to use such mikes with amplifiers of limited gain. It is unfortunate that some of the finest mikes do not have greater sensitivity, but such is the case. A tabulation of representative types of microphones and their range of sensitivity is shown in Table I. Note that the ranges given are not for a single type of mike but for the most sensi-

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# Radio Service-Dealer

January to December, Inclusive

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see C<sub>3</sub>. Here, the lowest frequency signal is also obtained with maximum padder capacity and we always start from maximum capacity and work out. We select the second peak. On broadcast we select the first peak in making adjustments, since the oscillator is to be aligned on the high side of the signal.

The sensitivity of the set should be checked by running the signal generator dial in step with the receiver dial and noting any wide change in output as this is done. It takes a little practice to get the hang of turning the generator dial with the left hand while moving the receiver dial with the right, but it is a useful test. In this way, dead spots are found. Some receivers are so poorly designed that absorption takes place and there is nothing you can do about the dead spots due to coils being crowded into spaces where an ant would need to wriggle to get through. But the manufacturers don't build commercial brand radios to have perfect short wave

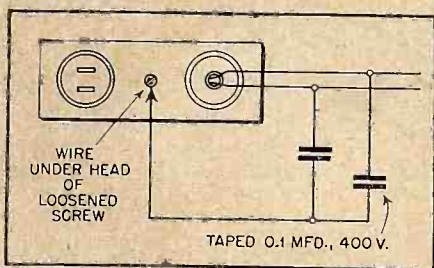


Fig. 6. A simple line filter.

response although many of them are pretty good. So just keep that point in mind before deciding your alignment job is not the best that can be done. For example, in tuning the dial of a typical set from 6 megacycles to 20 megacycles it was found that dead spots occurred 12 to 14 and 9-10. Moving a hunk of paper condenser out of the field of one of the short wave coils cleared up the condition.

### Noise Filters Help

Surprisingly enough, a line noise filter seems to work very well on short wave, even better than on broadcast, and to boost signal strength. It may consist of two condensers, so arranged that each side of the power line input to the radio is by-passed to ground. The ground connection may be on the wall plate of the electric outlet and should be short and direct. This is shown in Fig. 6.

Profits in servicing these days are greatest when you go after and do

the jobs which require skill and labor rather than material. The data given here, it is hoped, will help you do just that.

★

## The Tube Situation

The critical shortage of replacement tubes is apparent to all Service-Dealers and Jobbers. On November 27th the Crosley Corporation of Cincinnati sent a letter to all their distributors. We reprint that letter in full that all "RSD" readers may

have a clear picture as to how matters stand.

To ALL CROSLY DISTRIBUTORS:

Many Crosley distributors are having difficulty obtaining radio tubes. This letter has been prepared to assist in this problem.

All radio tube manufacturers have on hand government orders many times their maximum peace-time production. As a result but few civilian types of tubes are being manufactured and many tube models are becoming very scarce. Government release on additional civilian tube manufacturing has been very slow due to their inability to determine exactly the number of tubes  
(Continued on page 25)



## "Of Course, I'd Rather Use My Car

★

... but if the boys in the service need the gas, I'm satisfied to do with less".

★

People have willingly given war needs a priority over civilian desires.

★

If you explain to your customers why radio parts are scarce—and how you licked an "impossible" situation to get their sets operating at all—they will accept those repair jobs that may be "a little less than perfect."

★

Naturally, you don't like to work on the antiquated sets you're getting today—especially with the shortage of men and materials. But, it's your patriotic duty to keep 'em playing—even if you have to improvise repairs. Of course, to do this efficiently you must know exactly *what's inside the set.*

★

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★

So, don't waste time "guessing out" defects and "experimenting" with possible methods of improvising repairs. Reach for one of your thirteen Rider Manuals when you begin *every* job. It's good sense and good citizenship to work efficiently today. It conserves parts and saves labor—both critically scarce right now.

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## MODERN P.A. AMPLIFIER DESIGN PRACTICE

(Continued from page 18)

coil resistance is low, it is possible that considerable power will be lost in the line when this method of connection is used, due to the resistance of the leads.

When several loudspeakers are being used, it is essential that their voice coil impedances be identical if they are to be connected in series or parallel. If not, separate coupling transformers, with primary impedances of identical value—generally 200 or 500 ohms—should be employed. If four speakers are being

used, with 500-ohm coupling transformers, they may be connected in series-parallel to provide an impedance which remains at 500 ohms for coupling to the output transformer of the amplifier. When the taps on the output transformer do not match any of the impedance values of the speaker transformer or voice coil, it is better to connect to a tap of lower impedance rather than of higher impedance, for minimum distortion. In general, considerable mismatch is possible before noticeably bad results are obtained, so don't be too academic about it.

### Feedback

Acoustic howl due to feedback is one of the most common annoyances

encountered in p.a. work. The remedy, of course, is to keep the reproduced sound from the loudspeaker from getting back into the amplifier input circuit via the microphone, but there are times when this is none too easy. The first step is to place the loudspeakers in such manner that reflection of the sound back of the mike is at a minimum. When this is difficult or impossible, the next best method is to shield the mike acoustically. This is accomplished by placing it in a box padded with sound absorbent material, such as cellotex. A small hole is cut in the box to speak into. This arrangement affects the fidelity somewhat, though not as much as one might expect, but does eliminate acoustic feedback.

### Trap-Circuits

Some microphones are more subject to trouble with acoustic feedback than others. This is the case when a resonant peak is present in the mike response curve. The same effect is caused, and more frequently, by peaks in the loudspeaker response. This effect can be noted by taking cognizance of the howl frequency. If a trap circuit is introduced—simply an iron-core choke and condenser in series—across the grid circuit of one of the amplifier stages, this peak may be greatly attenuated so that the microphone may be used closer to the speaker. The values of choke and condenser may be varied until the desired frequency is obtained. This is facilitated by using a calibrated audio oscillator to determine the frequency, whence it is possible to compute the required values of capacitance and inductance for the trap circuit.

Placing the microphone in another room, totally shielded acoustically from the loudspeakers, or well back on a stage, with the loudspeakers set in the walls in front and at each side of the stage, are methods frequently used to minimize acoustic feedback. When the operator of the amplifier is not in the audience, it is somewhat difficult to gauge the required volume level. This is best determined by test beforehand, noting the level on an output meter connected across the amplifier output when an assistant advises that the level is satisfactory. This may then be maintained during the performance.

Volume compressors and expanders have advantages in many p.a. applications. However, these circuits are rather involved and are therefore being considered in a separate article to follow.

★ BUY WAR STAMPS ★



The illustration depicts a large, futuristic speaker horn dominating the left side of the scene. In the background, several biplanes fly across a cloudy sky. In the foreground, a group of soldiers in military uniforms are gathered around a large, rugged vehicle, possibly a tank or a heavy transport, on a battlefield. The overall tone is dramatic and emphasizes the ruggedness and power of the speakers.

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## THE TUBE SITUATION

(Continued from page 23)

on hand for all distributors or accounts. We can, therefore, expect but little relief during the next few months.

There are tubes available, however, each tube manufacturer does not have all tubes and certain tubes are not available at all. Tube characteristics are such that your radio service man can make many tube substitutions by slight changes in the circuits, which do not affect the set's performance. Tube data sheets, which various tube manufacturers have supplied and are still able to supply, furnish this information.

To obtain tubes, it is first necessary that a PD-1-X, properly filled out, is presented to the War Production Board. The following instructions, if carefully followed, will assist you in obtaining priority assistance.

1. Use a separate line for each tube model number. Enter the tube model number in Column B.
2. In Column C, enter your physical inventory, as of December 31, as closely as possible in dollar value.
3. In Column D, enter your receipts of the particular model tube from January 1 to date of filing the PD-1-X. Remember that if a PD-1-X form is entered Dec. 1, 1942, the amount shown in Column D is for eleven months, and 1/11 of this amount will represent to the War Production Board your monthly purchases.
4. Column E is to show your inventory for each model as of the filing date. In handling your application, the War Production Board will add together Column C and Column D, and subtract from this Column E, to determine usage for the period covered. Again, considering eleven months, your monthly usage would be taken as 1/11 of this amount, that is, Column C, plus Column D, less Column E. The amount which you can request in Column F will be 1½ times this figure. If anymore is requested, it will be denied.
5. Column A can then be filled out with a quantity, the cost of which will be equal to the value determined in Column F.

The handling of the PD-1-X form by the War Production Board is on the basis of simple arithmetic, as shown above. If the result of the arithmetic shows a request for more than a 1½ month's supply, the request will be denied. The amount of time and effort necessary to obtain priority assistance by means of this form can be greatly reduced by paying careful attention to the above instructions.

After obtaining approval and a priority rating of A-3, or better, tubes may be ordered from anyone of the following companies:

Hytron Corporation, Salem, Mass.  
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.

National Union Radio Corp., Newark, N. J.

Raytheon Production Corp., New York, N. Y.

RCA Manufacturing Co., Inc., Camden, N. J.

Standard Arcturus Corp., Newark, N. J.

Sylvania Electric Products, Inc., Emporium, Pa.

Tung-Sol Lamp Works, Inc., Newark, N. J.

If certain tubes cannot be obtained from your regular source of supply or anyone of the above listed companies, do not hesitate to try another supplier. It is a strict ruling from the War Production Board that manufacturers hav-

ing replacement tubes available must accept and fill orders according to priority rating, regardless whether or not previous purchases have been made by the customer. If any manufacturer should refuse to ship because they have not furnished you tubes in the past, advise Mr. Frank MacIntosh, War Production Board, Room 4320, Social Security Bldg., Washington, D. C.

We sincerely hope that the above information will be of assistance to you in obtaining those radio tubes necessary to continue your radio service operation.

(Signed)

H. A. Newell  
General Service Manager,  
The Crosley Corporation



# RELAYS



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## CHOOSING A MICROPHONE

(Continued from page 19)

tive and least sensitive in each category. These ratings, it must be emphasized, cover only the range of sensitivities among various models of each type. They have no bearing on the relative fidelity except, as we have pointed out before, that the less sensitive are generally better insofar as fidelity is concerned. This point is of importance mainly in broadcast work; in ordinary p.a. work, fidelity is not so very important.

### Determining Amplifier Ratings

Since the sensitivity of microphones is inseparably tied up with that of the amplifier with which it is to be used, it is perhaps well to discuss here the method of determining amplifier ratings too, particularly as an article on amplifiers (the "TECHNICAL SERVICE PORTFOLIO") is also included in this issue. Amplifier gain may be found from the formula

- (a) Amplifier gain (in db) =  $10 \log \frac{\text{Output Power}}{\text{Input Power}}$
- (b) Amplifier gain (in db) =  $10 \log \frac{\text{Output Voltage}^2/\text{output load in ohms}}{\text{Input Voltage}^2/\text{input load in ohms}}$
- (c) Amplifier gain (in db) =  $20 \log \frac{\text{output voltage}}{\text{input voltage}} + 10 \log \frac{\text{input load}}{\text{output load}}$

Although these three formulas all give the same result, in practice it will save time to use the one most suited for the amplifier at hand. If the amplifier has a transformer-coupled input—and there are not many of this type used for p.a. work—we need simply consider the power in the 500-ohm line, or what ever is used in the input circuit—and the equivalent impedance of the output circuit. Thus, if the input and output impedances are identical, we find that in formula (b) we may forget about the input load and output load part of the formula and express the ratio in db based simply upon the measured output voltage squared and the measured input voltage squared.

With amplifiers having a high impedance input, such as the unadorned grid input with only a 2-megohm leak from grid to ground in the circuit, the matter of obtaining a

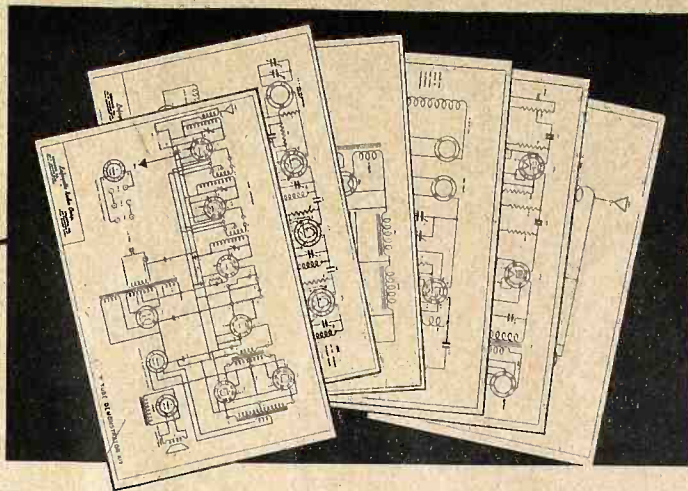
power ratio leads us into difficulties. For, if the 2 megohm resistance is replaced by a 20-megohm resistor, the gain of the amplifier will not be increased in the slightest degree, yet the ratio of output power to input power will be greater. This formula (a) will not work in such instances. This should be qualified by stating that the formula applies only in such cases where the microphone impedance equals that of the input resistor employed. Because the amplifier resistance will always be much higher than the impedance of the mike, the gain will be the same no matter whether the input resistor is 2 megohms or 20 megohms. Because of this anomaly, it is now customary to state in the amplifier rating just what input resistance is assumed in making the calculations. Usually this is specified as 150,000 ohms. Actually, the resistor used is always higher than this value.

A much better form of rating amplifiers is to specify the voltage input required for full output. If for instance, we know the microphone rating to be -60 db, then we also know its output (open-circuit) is 1 millivolt for a sound pressure of 1 bar. If we have an amplifier which will deliver full rated output for 1 millivolt or less input, then we may rest assured that it has adequate gain for the microphone we have in mind, rated at -60 db. Otherwise we will have to calculate the voltage which will appear across the amplifier output load when operating at full rated output, determine the input voltage on the basis of the microphone output, and taking into consideration the load of the amplifier input circuit, and consider the load resistance in the output and input circuits. Then, by applying formula (c), we may calculate the gain required for full output or, if we already know the gain, we may determine whether or not it is adequate.

In general, an amplifier with a rated gain of 130 db will take care of even the most insensitive mike encountered in public address work, operating the amplifier at an output level of approximately 10 watts. This is adequate for most large halls,—in fact, you can do a lot with even 5 watts in an enclosed space. For outdoors, considerably greater power is required, and consequently a greater gain or a more sensitive mike.

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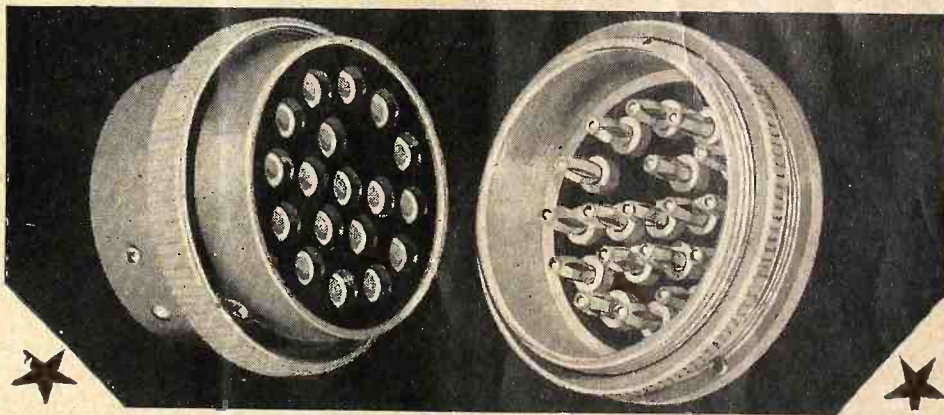
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Contributing to the war effort, Astatic Corporation facilities are being utilized today mainly in the manufacture of essential products requiring special engineering skill and precision. Among these are Aircraft Radio Plugs

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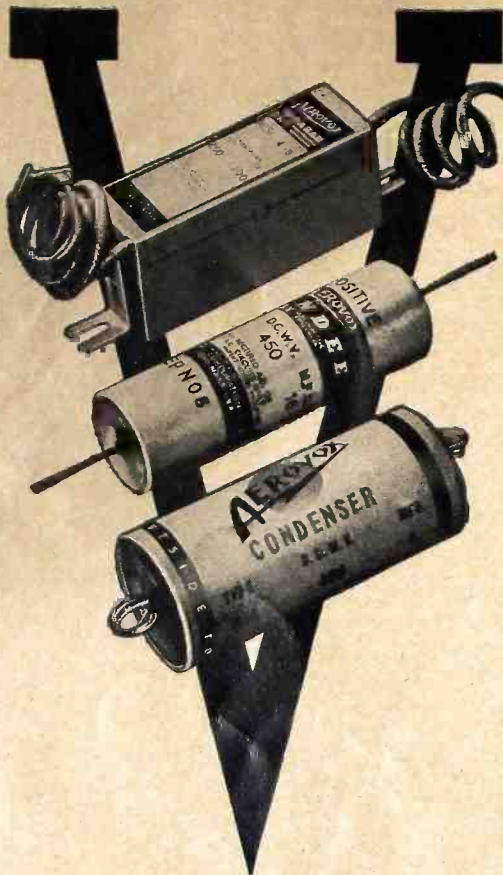
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YOUNGSTOWN, OHIO

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2A3	6K7 C or GT
2A4C	6L6 C or GT
5U4C	6SC7 or GT
5V4C	6SQ7 C or GT
5Y3C or GT	30
5Z3	45
6B5	70L7GT
6C6	76
6H6 C or GT	80
	2051

### W. R. BURTT

308 Orpheum Bldg. Wichita, Kansas

## Book Review

*MYE TECHNICAL MANUAL*, published by P. R. Mallory & Co., Inc., Indianapolis, Ind. Stiff cloth cover, 8½" x 11" page size, 407 pages including index and tube base wiring diagrams. Price \$2.00.

To properly review this volume, the Fifth Edition of MYE, consisting of 13 excellent Sections, would in itself require a book. Suffice, then, to say that the 1942 MYE is the best yet. By listing the titles of the 13 Sections we outline its broad content: 1, "Loud Speaker Design & Application" — 2, "Superheterodyne First Detectors & Oscillators" — 3, "Half-wave & Voltage Doubler Power Supply Systems" — 4, "Vibrators & Power Supplies" — 5, "Phono-radio Service Data" — 6, "Automatic Tuning" — 7, "Frequency Modulation" — 8, "Fundamentals of Television Engineering" — 9, "DC Dry Electrolytic Capacitors" — 10, "Practical Radio Noise Suppression" — 11, "Vacuum Tube Voltmeters" — 12, "Useful Servicing Information" — 13, "Receiving Tube Characteristics."

Profusely illustrated with schematics, wiring diagrams, graphs, photos, charts, nomograms and tables, the MYE Manual will prove invaluable to all who are engaged in any phase of radio-television-electronic maintenance work.

★

#### EICOR EXPANDS

»» Eicor, Inc., manufacturers of Dynamos, D.C. Motors, Converters, Power Plants, and other rotary electrical apparatus, moved to 1501 W. Congress Street, corner of Congress and Laflin, Chicago, to provide more factory space and production facilities to meet the tremendously increased need for Eicor Products in the war program.

Quality above all.

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## "Well Done"

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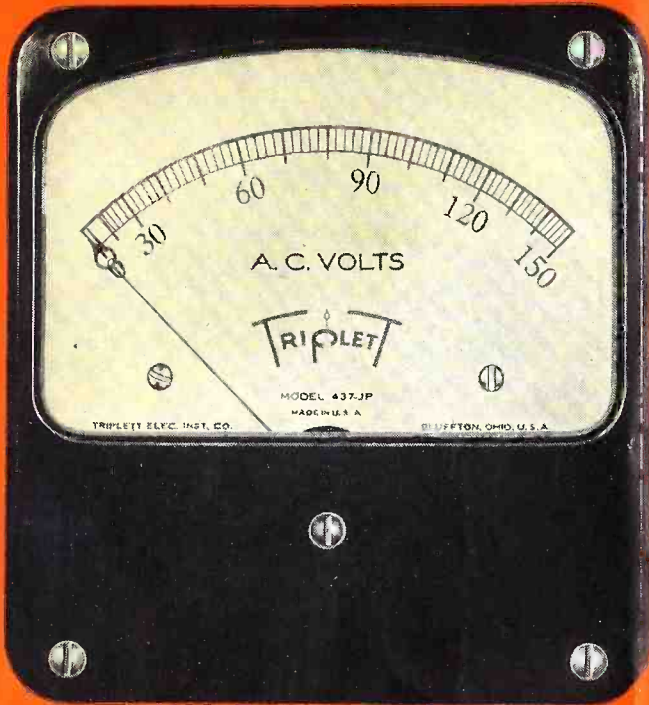
# TRIPPLETT

**NEW**

*Combat Line*

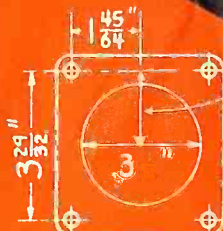
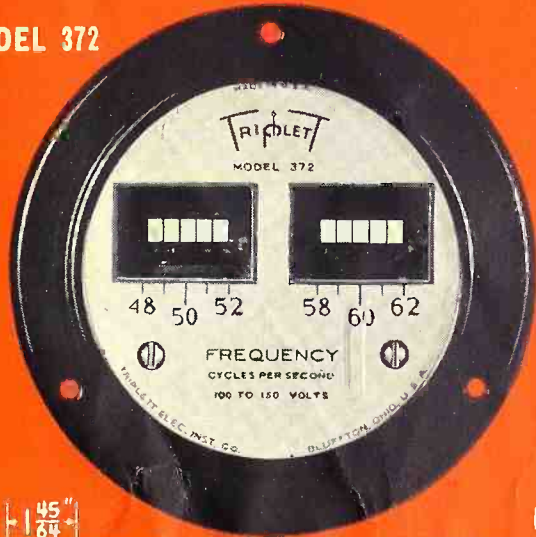
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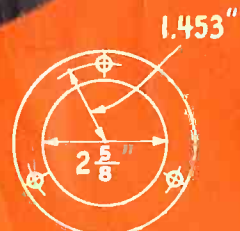


**MODEL 437-JP**

**MODEL 372**



Model 437 - J P

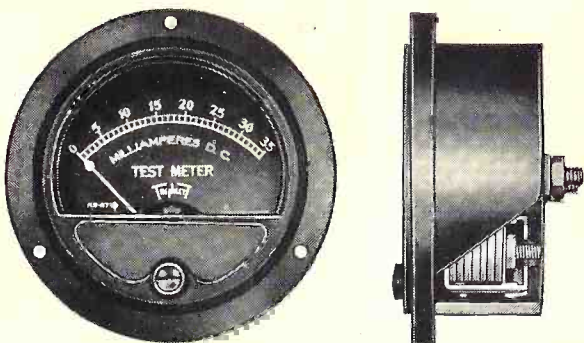


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Precision performance by new *thin* instrument with *standard* Triplet movement housed in either metal or molded case. No projecting base; wider shroud to strengthen face; simplified zero adjustment; balanced bridge support; metal bridges at both ends; doubly supported core. For "Precision in limited space" write for Triplet Thin Line Bulletin.

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New Answers to specialized needs of War: Production Speed-up and Standardization; Performance under the Stress and Vibrations of Combat Service.

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**RADIO TUBES**



DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES FOR THE NEW ERA OF ELECTRONICS

# Radio SERVICE-DEALER

SOUNDMAN AND JOBBER

Reg. U. S. Pat. Off.

Vol. 3, No. 12 ★ December 1942

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**Executive & Editorial Offices**  
**132 West 43rd St., New York**

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*The Staff of  
Radio Service-Dealer  
extends to all a  
wish that you have  
A Merry Christmas  
and a  
Happy New Year*

## Cover Picture

(Official Signal Corps Release)

### SIGNAL CORPS CACHET

This is the first publication release of the new cachet that the Signal Corps is urging manufacturers to display in an effort to obtain enlistments.

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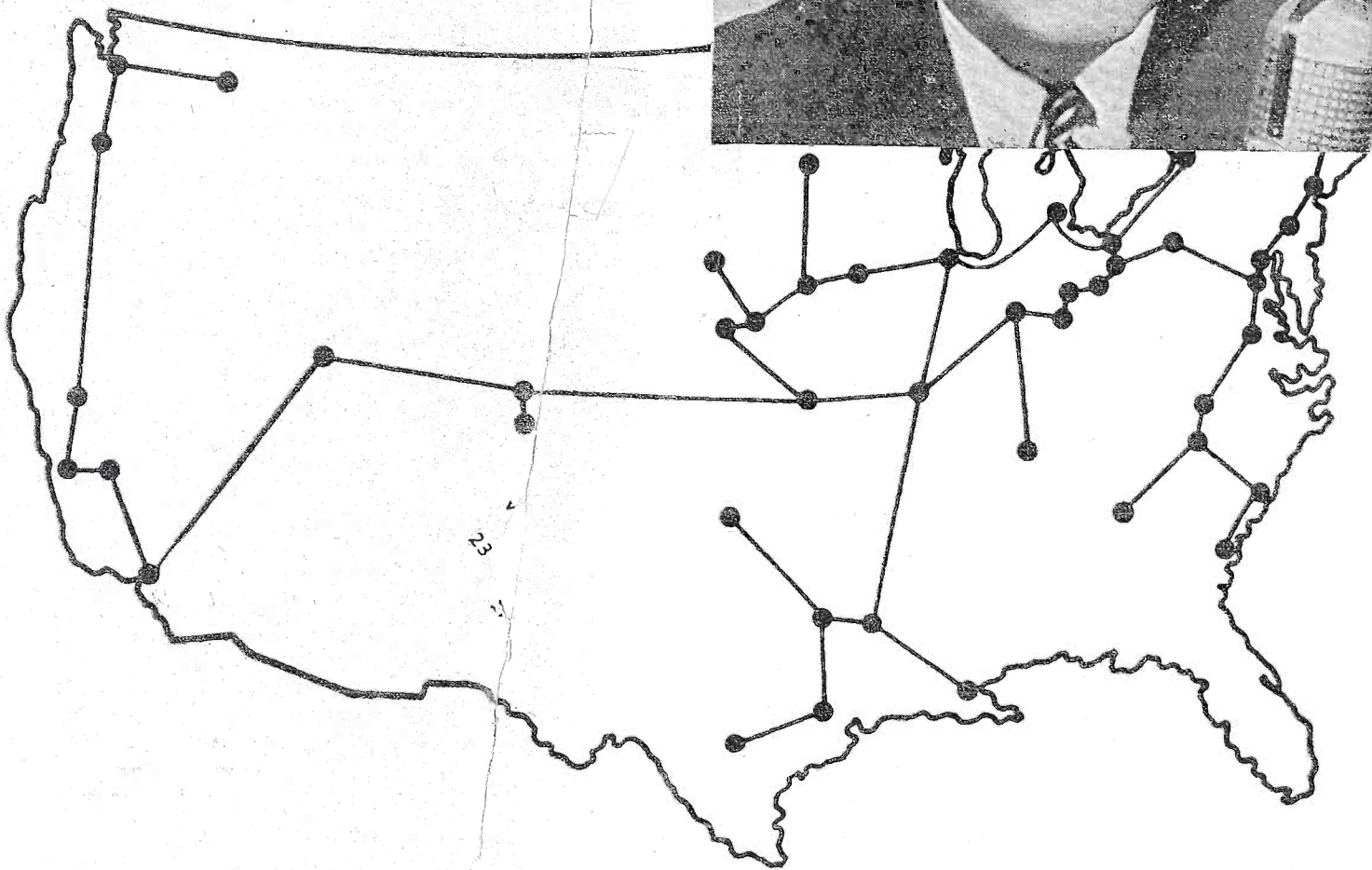
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Radio Service-Dealer, December, 1942

# G. E. is telling your customers Service over 51 C.B.S.

*The General Electric radio news program, with Frazier Hunt, is explaining to your customers your difficult wartime radio service problems.*



**GENERAL**  **ELECTRIC**

Leader in Radio,

Radio Service-Dealer, December, 1942



# about Wartime Radio and 8 FM radio stations

ON DECEMBER 1, the General Electric radio news program, featuring Frazier Hunt, started telling your customers of your wartime radio service problems.

G.E. fully appreciates the difficulties under which radio service men are operating, and is anxious to prevent any public misunderstanding that would reflect on your service business.

Therefore, the G-E radio news program is pointing out over and over that, with so many radio service men now in the armed forces, the task of those still on the job is tremendous and is being met in many cases by day-and-night work. G.E. is explaining that although fewer service men are available to keep the nation's 50,000,000 radio sets working, the hard job

can be done if the public will be just a little patient.

The public is also being reminded that some radio parts are now difficult to get in a hurry. Furthermore, it is being asked to remember that rubber and gasoline rationing are as hard on the service man as on themselves. So radio owners are asked to carry tubes and small sets to you, rather than ask you to go to them.

Above all, G.E. asks the public to understand that you are doing a great job under trying conditions, and that wherever possible G-E electronic tubes and other replacement parts on hand are being rushed to help keep your wartime radio service going. . . . Radio, Television, and Electronics Department, General Electric Company, Schenectady, New York.

## G. E. IS TELLING YOUR SERVICE CUSTOMERS THAT:

Thousands of former radio service men are now in the armed forces. Those left in service shops are doing an important job — well! Everything possible is being done to keep America's 50,000,000 radios working. A little customer patience over delays is asked for — and appreciated. Gasoline and rubber are scarce, so please bring tubes and small sets to the service men whenever possible.



Television, and Electronic Research

# editorial . . . .

## The "Victory Line"

• At the request of OPA and WPB the American Standards Association is making a study to determine whether it will be feasible and practical for radio parts manufacturers to produce a "Victory Line" of replacement parts. Such a line would ostensibly take the place of Private Brands which have been nationally advertised, guaranteed and distributed since the radio industry's inception. It is well known that Private Brands are now being diverted to war equipment and are practically inaccessible for civilian radio maintenance because that classification has such a poor priority status.

Before becoming exuberant about the "Victory Line" radio service-dealers and jobbers must weigh *all* the facts. To help you obtain a true picture, let us quote from the ASA's first publicity release (following which our own observations will be given): "Considerable care is being exercised by the ASA committee to make sure that the quality of the standard repair parts chosen will be suitable from the set owners' standpoint . . . sufficient parts of each type will be included . . . to adequately service almost all of the modern home receivers in use today. Tubes are not included in the project.

"In the design of these standard parts the ASA is making every effort to provide units that will be mechanically interchangeable with present parts with a minimum of difficulty.

"Through simplification of the number of varied ranges now in use and the use of multi-purpose units when practicable, the actual number of parts will be held to an absolute minimum in the forthcoming standards . . . for example, some 62 standard volume controls have been proposed to serve as replacements for the thousands of different types used in home radio sets built during the past half dozen years while 9 electrolytic and 11 paper capacitors have been proposed to do a similar job in the capacitor field. Similar simplification and standardization in other radio parts such as transformers, chokes, coils, etc., is also included in the scope of the project now getting under way."

The ASA announcement also bears *this very significant phrase*, "the WPB and OPA are expected to allot materials for manufacture of the standardized parts and to issue limitation and price orders." Brother—do you see the "catch"? That sentence "the OPA and WPB *are expected* to allot materials, etc." is a joker of the first water. This writer and many parts manufacturers have been given such "anticipated promises" by WPB since the very inception of priorities.

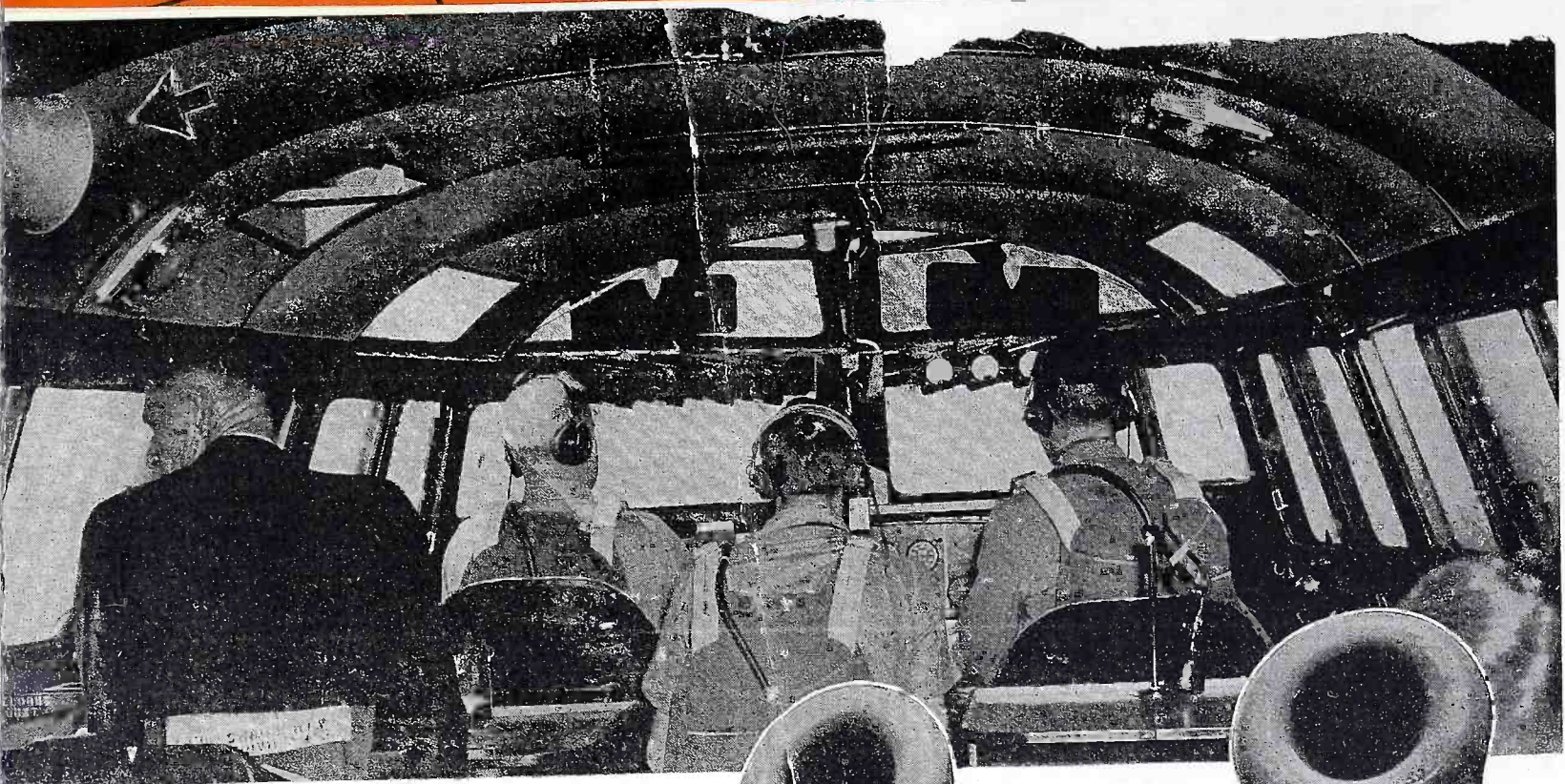
The next catch, in the "Victory" plan, is that radio tube production is excluded entirely. Tube manufacturers frankly admit they are swamped with war orders, their production facilities are tied up for months to come. There are no renewal tubes available for service-dealers. What good will replacement parts be without renewal tubes?

Finally, what about a "Victory Line" that requires new tooling and additional plant facilities, which probably cannot be provided for? And don't forget the new Controlled Materials Plan, which inherently prohibits the production of parts for any civilian use! No, gentlemen, there is but one commonsense answer to the whole radio parts and tube shortage, and it is this: if the WPB and other Washington bureaus stop vacillating and decide that maintenance of civilian radio receivers (at least one in every home) is going to contribute to the war effort, morale or what have you . . . then Washington must simply allocate the necessary metals and materials to parts and tube manufacturers and the latter groups will find the ways and means of producing a short standardized line of useable replacements. We do not favor advertised brands merely because our livelihood is derived from advertising. We do know, from twenty years of practical experience in radio, that so-called "Victory Lines" would probably be sub-standard, impractical to conceive and produce and unsatisfactory in-so-far as proper distribution and substitution for standard brands is concerned.

## Gasoline Rationing

• At the outset of gas rationing we implored OPA to recognize the radio service-dealers' unique status and need for supplementary additional gas. Eventually OPA issued an Order allowing radio repairmen extra gas. Correspondence in our files would indicate that in fact, they are not getting it. Local Ration Boards in big cities have denied service-dealer applicants for "C" cards on the basis that they have suitable regular means of transportation at their disposal to take care of the extra mileage they must cover. Local Ration Boards in suburban and "hick" localities deny extra rations on the premise that the customers must be made to bring in their sets rather than have them picked up, even at centralized pick-up depots, that progressive servicemen have had the foresight to establish. Here is vacillation of the worst order. Either radio maintenance is entitled to recognition for its importance to the public weal, or radio repairing should be designated as "unessential." That point should be decided, but definitely. The average service-dealer is trying to handle six to eight times his normal volume of repair work because eight out of every ten radio servicemen have already entered military service. Give the average service-dealer the same amount of gas he formerly used in the conduct of his business and he will be able to handle the many-times-doubled extra volume of work now forced upon him. That is true expediting and proper use of available manpower.—That is true gas and rubber conservation. What about it OPA? When will practicable standards that lend themselves to the war effort be established? An OPA directive to *all* Ration Boards to grant servicemen a reasonable amount of gasoline will solve the problem once and for all.

**SRC**



## RACONS do their bit—

\* Under prime and sub contracts RACON Products contribute to many phases of the war effort. For example, shown here is a RACON Marine Horn Speaker in the cabin of the B-19; and in the other extreme, on the ground a Sperry anti-aircraft detector battery, the three locator horn units of which were made by RACON.

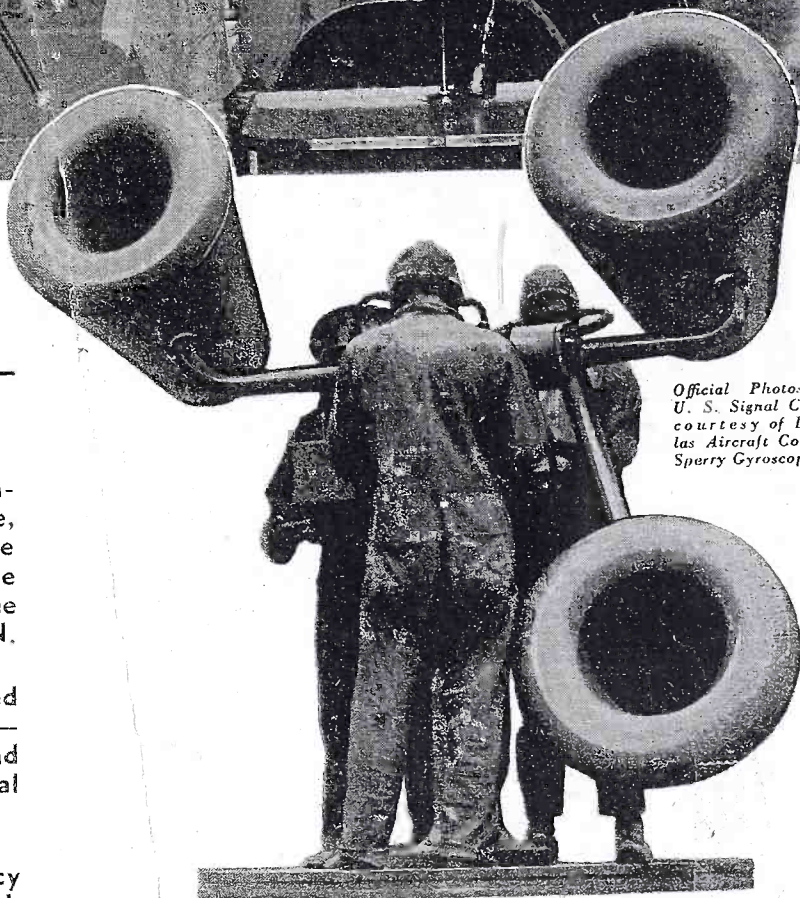
\* If space permitted we'd show how RACONS are used at Army and Air Force training bases—at shipyards—aboard Navy, Coast Guard, Maritime Commission and Transport ships—in factories, and in countless industrial public-address systems.

\* The most important point is this, the quality, efficiency and dependability of RACONS have long been recognized. There's nothing finer. RACONS deliver more energy per watt input. They use RACON's exclusive Waterproof, Weatherproof, Acoustic Material. The elements cannot affect RACON's efficient operation. Use RACON's when planning your next installation. There is a horn, speaker or driving unit for every conceivable purpose. Inquiries are invited—perhaps we can help you in some phase of the war effort. Ask for our free catalog, too.

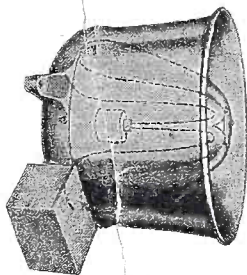
RACON ELECTRIC CO., 52 East 19th St., New York, N. Y.

# RACON

Radio Service-Dealer, December, 1942



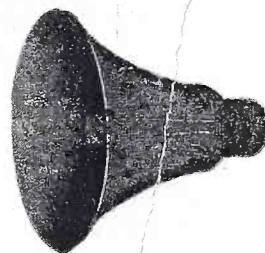
Official Photos by  
U. S. Signal Corps;  
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MARINE  
HORN SPEAKERS

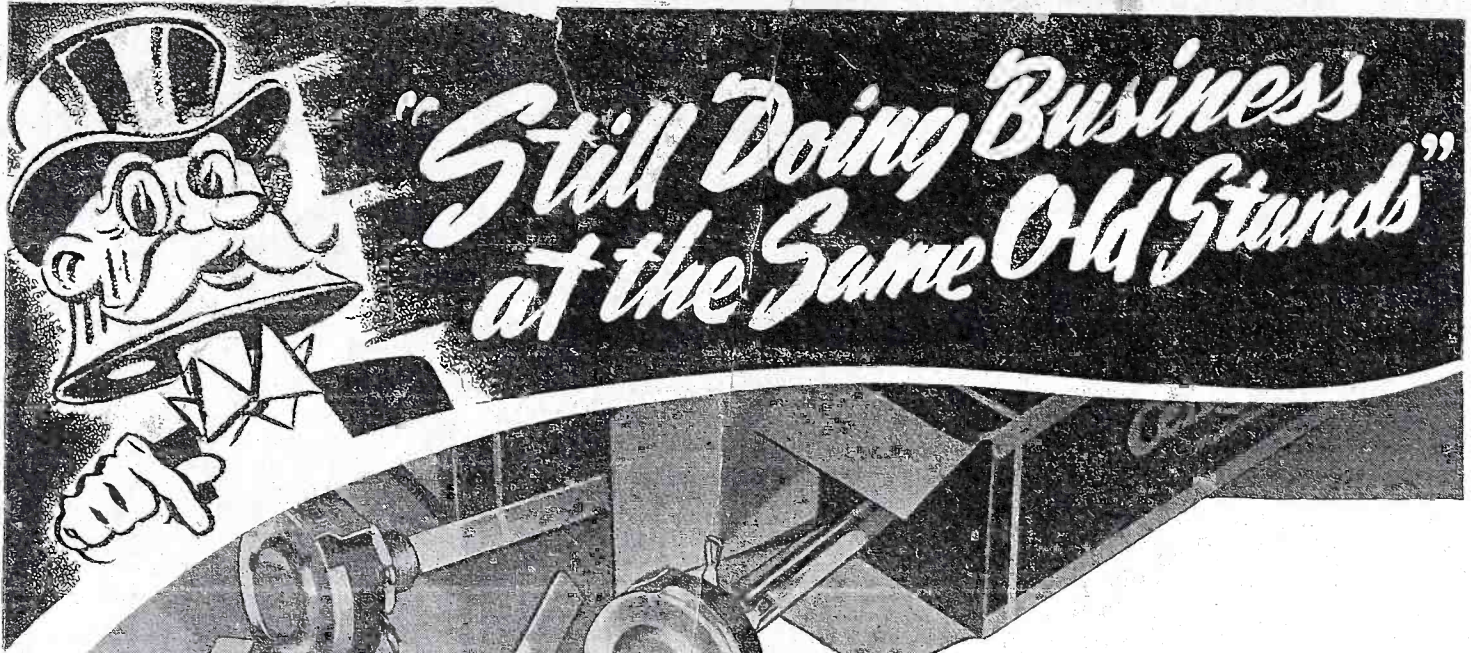


RACON P. M.  
HORN UNITS



RE-ENTRANT  
TRUMPETS

Shown here are but two of the many RACON Speakers and one type of RACON P. M. Horn Unit. The MARINE HORN SPEAKER may be used as a loud-speaker or microphone, comes in several sizes; is approved by the Bur. of Marine Inspection, Dep't. of Commerce. MARINE CONE SPEAKERS are the re-entrant type, suitable for indoor or outdoor use. Stormproofed for all weather conditions. Sizes for 2, 3, 5, 8 and 12 inch speakers. RACON P-M HORN UNITS are available in operating capacities of from 5 to 50 watts.



*"Still Doing Business  
at the Same Old Stands"*



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... your Distributor can  
*STILL* Supply you with

# Centralab

## MIDGET RADIOHM REPLACEMENTS

Fortunately . . . your distributor  
can still supply you with Midget  
Radiohms for replacements.

The smooth wall-type resistor for  
which Centralab Radiohms are  
famous will keep that now-precious  
radio in good working condition.

Stick to OLD MAN CENTRALAB  
for Replacements . . . and always  
specify "CENTRALAB".

- RADIOHMS • FIXED RESISTORS
- FIXED AND VARIABLE  
CERAMIC CAPACITORS
- SELECTOR SWITCHES

**CENTRALAB:** Div. of Globe-Union Inc., Milwaukee, Wis.



## CHOOSING A MICROPHONE

by John A. Potts

**W**E hope that no one, in glancing at the title of this article, or at the illustrations of mikes appearing herewith, will be led to believe that there are places where a plentiful variety of microphones is available from which he may select whatever pleases him. Far from it. And because microphones are scarce and limited in variety, it is all the more important that we be sure, before we start looking around, that the type we have in mind is the proper one for the job. Also, because we may not be able to find just what we want, we need to know if some other type, perhaps easier to get, may possibly do the trick as well. We must also consider whether the amplifier we plan to use has sufficient gain and is otherwise adaptable for use with the microphone we intend to use. Therefore some discussion of microphone sensitivity ratings is in order, particularly since these ratings have undergone revisions in recent years.

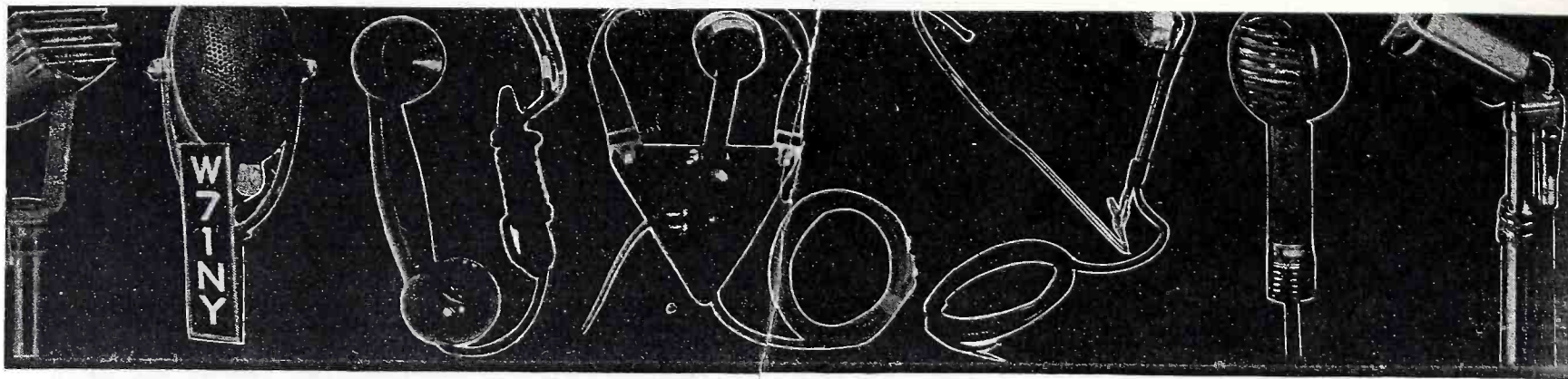
Fundamentally, microphones may be divided into three classifications,

(1), those in which a sound wave acts upon a ribbon or diaphragm placed in an electro-magnetic or electrostatic field and thus causes a variation in the intensity of this electric field and, consequently, of the potential across the output terminals of the device, (2), those in which the sound wave creates a voltage across a crystal of the Rochelle salt variety, due to the phenomenon known as piezo-electricity, (3), those wherein the sound wave causes the resistance of carbon granules to vary, and thus varies the current in a circuit of which the granules form a part. All these types are in common use, but each has its own peculiarities, advantages and limitations.

### Ribbon Mikes

In the first classification we find the ribbon, or velocity, microphone and the moving coil, or dynamic type. In the former, a thin strip of metal is placed between the poles of strong permanent magnets so that its width is in the plane of the electromagnetic field. The dif-

ference between the sound pressure at the front and back of the ribbon causes the ribbon to move and thus varies the electromagnetic field in synchronism with the sound frequency. Because the ribbon must be thin, light, and of low resistance in order to respond freely to high, as well as low, frequencies, it has an extremely low impedance. Therefore a coupling transformer is usually built into the microphone case, stepping up the impedance from a few ohms or less to perhaps 200 ohms or more at the output terminals. The sensitivity of the ribbon microphone is often low in comparison with many other types, but this is counterbalanced by excellent fidelity. In general, this applies to most microphones—the greater the output voltage they supply, for a given sound level, the poorer the fidelity. The ve-



**MICROPHONE TYPES**—(from left to right)—Electro-Voice, Dynamic; Western Electric Experimental Synchronized F-M, Condenser; Universal, Carbon handset; Universal, Magnetic field type; Universal, Military; Shure plastic cased Crystal; Webster, Super Dyne.

locity microphone is excellently adapted for studio work because of its fine fidelity. Likewise it is extremely useful where the microphone must be placed in the same room with loudspeakers, because it is highly directional, especially the cardioid type, so it may be placed at such an angle to the sound waves reflected back toward the microphone that they will not get into the mike and cause acoustic howl. Because there is a transformer in the mike, it must be kept well away from magnetic fields, such as the power transformer in the p.a. amplifier, or any rotating electrical machinery in the vicinity, otherwise hum results. The output level is rated around —74 db below 1 volt per bar (we'll say more about this later on.)

The moving-coil, or dynamic, microphone also operates on the electromagnetic principle. In fact, this type of microphone is quite similar in principle to the ordinary dynamic loudspeaker. A moving coil of aluminum ribbon, attached to a dural diaphragm, is suspended in an electromagnetic field. When sound waves strike the diaphragm, it vibrates, thus causing the moving coil to move in like manner within the electric field. This movement cuts the magnetic lines of force and thus creates a voltage across the moving coil. An impedance-matching transformer, built within the mike housing, steps up the low moving coil impedance to an output value of 200-500 ohms. In some types, this transformer is

omitted and the output terminals connect directly to the moving coil, the impedance of which will be of the order of 20 ohms. This type of microphone delivers a somewhat lower output voltage (when no transformer is built into the mike) than the velocity type with the transformer so that its rating is lower—about —88 db—and therefore an amplifier with higher gain is required. If a coupling transformer is used—and it should be for maximum efficiency—the same precautions regarding the placement of the mike with respect to electromagnetic fields must be observed, as with the velocity type. This type of microphone is responsive to sounds reaching it from all directions, and is accordingly termed “non-directional.” The advantage of a non-directional mike is that a sound source extending over a wide area, such as an orchestra, can be handled by a single mike, or a speaker who has a tendency to meander around the platform may be picked up more easily and uniformly. The disadvantage is that greater care must be exercised in the placement of loudspeakers in order to avoid feedback. This may be overcome by placing the mike in a reflector of some sort—the parabolic type has been used—which will make it directional.

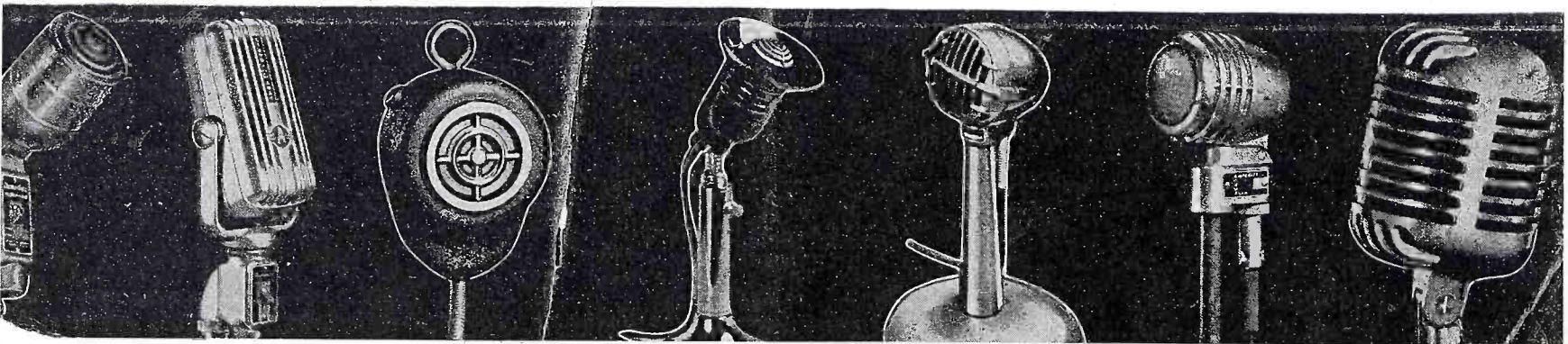
#### Crystal Mikes

Crystal microphones have come into wide popularity, due in part to their sensitivity and simplicity of

operation. No coupling transformer is required, thus the precautions required with electromagnetic types of microphones are unnecessary. Their voltage output is relatively high, ranging up to about —64 db in the sound cell type and the frequency response characteristics are very uniform over a wide range. These mikes are essentially non-directional and are therefore adaptable to the same applications as the moving-coil type of microphone. The “sound-cell” crystal type, consisting usually of several individual crystals connected in series-parallel for maximum voltage output, is representative of the best of this type, insofar as fidelity is concerned. The diaphragm type, in which sound waves striking a diaphragm actuate a drive pin connected to the diaphragm and pressing against a corner of a crystal, which is independently supported within the mike housing at its three remaining corners, in such manner that the crystal is placed under mechanical stress, is the most sensitive type available, ranging up to —46 db. While all crystal mikes are high-impedance types, they may be used if desired, with coupling transformers when it is necessary to match a 200 or 500-ohm line. In such cases, the coupling transformer high-impedance secondary is connected to the crystal output, while the 200 or 500-ohm primary feeds the corresponding input circuit of the amplifier through the

*(Continued on page 19)*

**MICROPHONE TYPES**—(from left to right)—Electro-Voice, Dynamic; Amperite, Velocity; Electro-Voice, Carbon; RCA-Ribbon-Dynamic; Astatic, Crystal; Amperite, Dynamic; Shure, Cardioid.



The high regard in which IRC Resistors are held by Engineers and Executives of America's leading electronic industries is clearly attested by the voluntary remarks quoted at the right. These are taken from among returns to a nation-wide marketing study recently made by a wholly independent research organization. This survey was completely unbiased, with no company name or product disclosed.

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# METERING MIRACLES

by L. R. Byron

**Y**ES, miracles can be performed in connection with metering equipment, miracles in the way of saving instruments or in making old and discarded apparatus do the job and do it well. For, despite what the advertising boys have had to say about it, it is still possible for the technical expert to service a radio receiver with the simplest of equipment, provided he is willing to go to a little extra trouble and to use the old noodle. Too many servicemen reach for the soldering iron before stopping to think about what they are doing. I know because I've been one of them! But I reformed one day when looking at the contents of the cash till. It pays to think—to take an extra moment, and to use it wisely.

## The A.C. Meter

As an example of this line of reasoning, take the man who suddenly finds that the a.c. meter he has works all right on the voltmeter ranges but that something has gone kerfloey with the 0-15 or 0-5 a.c. ampere scale. After taking off the panel of his superdooper tester with its thousand and one wires, he wisely decides to let well enough alone in view of the fact the factory is swamped with war orders and meter specialists can't take care of civilian instruments. The a.c. current can be checked by inserting a resistor in series with the load, as in *Fig. 1*. If the set draws one ampere, a suitable value of series resistance is 3 ohms which will give a full scale deflection on an 0-3 volt a.c. meter. There will be a slight voltage drop to the load, but the accuracy of measurement will be sufficient for practical purposes. The current is, of course, the measured voltage di-

vided by the resistance in ohms. The power factor of such a set will be close to unity and the power therefore may be assumed equal to the product of voltage and current.

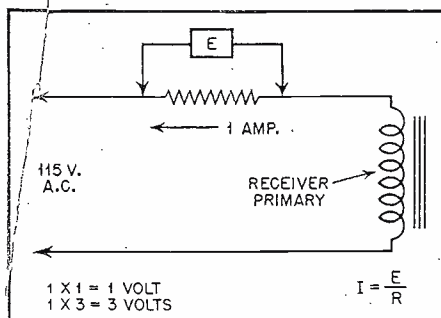
In connection with the accurate measurement of voltage on the plate of a tube having a high resistance plate load, you can use a fancy vacuum tube voltmeter or can measure the plate resistance and plate current as shown in *Fig. 2*. The plate voltage will be the supply voltage less the sum of the voltage drops in the plate load and cathode circuit resistances. The voltage drops are obtained by multiplying the current by the resistance. In the example shown, let us assume the current through the tube is .001 ampere. Then, the drop across the plate load will be  $100,000 \times .001$  or 100 volts. The drop across the cathode resistor will be  $1,000 \times .001$  or 1 volt. Also, let's assume the tube resistance is 100,000 ohms. Then, the sum of the voltage drops, according to Kirchoff's Voltage Law, is the sum of the individual drops and the supply voltage is 201 volts. Now, let's see what happens when we take a 1,000 ohms-per-volt meter and connect it from plate to cathode on the tube. Let's assume the meter resistance is 250,-

000 ohms. Under these conditions the net circuit resistance is about 172,111 ohms and the current is approximately .0011 ampere. The meter then reads 89.9 volts. Knowing the circuit resistance, the voltage drops for the bias resistor and plate load are figured. What's left is available for the plate of the tube. If the voltmeter had a resistance of 20,000 ohms per volt and were set on the 250 volt scale, it would read 99.091 volt. This would be about 9 volts higher than the reading with the 1,000 ohms/volt meter. If a vacuum tube voltmeter were used the reading would be 100 volts on the tube. Assuming an average milliammeter of 50 ohms resistance, the plate voltage reading would be 100 volts. The drop across the meter would be only .05 volt, assuming 1 ma. of current.

## Milliameters

The plate milliammeter can do other jobs as well. Referring to *Fig. 3*, the milliammeter indicates the plate and screen current by reading cathode current which is the sum of the two anode currents. Knowing the value of cathode resistance, the bias on the tube is found. A look at the RCA tube manual shows the plate current is 7 ma. and screen current is 1.7 ma. for a bias of -3 volts. The cathode resistance, therefore, is  $3/7$  plus 1.7 or  $3/8.7$  ma. This is 344 ohms approximately and a 350 ohm resistor would do. Now, referring to the tube curve given by the manufacturer, the plate current is about 7.3 ma. which is pretty close to the above figure.

We put a milliammeter in the plate circuit and read this value. Then, tuning the set to resonance with a strong local station, we again check



*Fig. 1.* To check a.c. current a resistor is placed in series with the load.



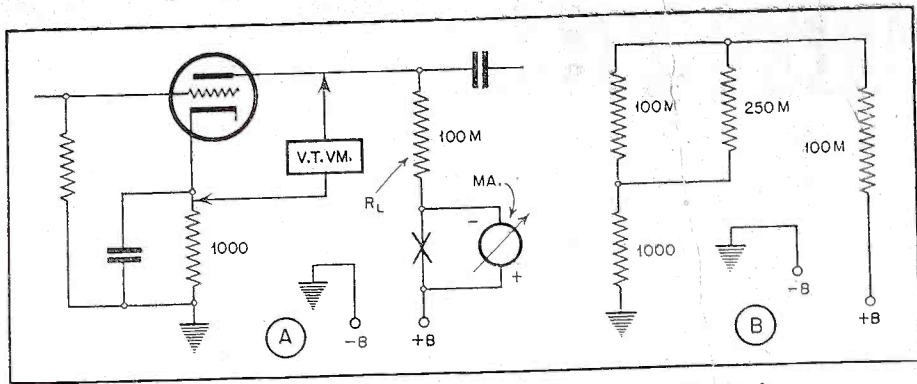


Fig. 2. Measure plate resistance and current to obtain the plate voltage, in a tube having high resistance plate load.

the plate current and find that it is down to 2 ma. Referring to the curve, we see that this value of plate current occurs when the bias on the tube is -10 volts. We now check the cathode current. We find it is 3 ma. Therefore the drop here is  $350 \times .003$  or 1.05 volts and the d.c. voltage across  $C_1$  must be  $10 - 1.05$  or about 9 volts. Thus, indirectly, we have measured the bias supplied by the a.v.c. system, without using a vacuum tube voltmeter.

Although it hasn't been used very much in recent years, the simple method of Fig. 4 is useful for checking tubes when a regular tube tester is not on hand. For example, assuming a 6C5 has a plate current of .005 ampere (5 milliamperes) and a bias of 2 volts, by cutting in series with the grid circuit another battery of -1.5 volts we raise the bias to 3.5 volts and the plate current is now down to .0025 (2.5 ma.). The change in plate current divided by the change in grid voltage and multiplied by  $10^6$  (1 million) equals the  $G_m$  or mutual conductance. In this case it would be  $5 - 2.5$  or 2.5 ma. for the plate current change. Then, .0025 divided by 1.5 gives .001666. Multiplying by  $10^6$  or moving the decimal point six places to the right, we get 1,666 mhos as the  $G_m$ . The figure given by the manufacturer in

the tube chart is 2,000 mhos and we would pass the tube as good. The shift in bias should be kept at a low figure to obtain a small shift in plate current. Then, best accuracy will result.

### Computing Voltage Amplification

In order to obtain the voltage amplification of a circuit such as the one in Fig. 4, we could use a vacuum tube voltmeter for the measurement of  $e_1$  and  $e_2$ . The ratio of  $e_2$  to  $e_1$  would be the gain. Thus, if  $e_2$  measured 10 volts and  $e_1$  was 1 volt the gain would be 10 times. Assuming the  $G_m$  is 2,000 mhos, the plate current is .001 ampere (1 ma.) and the plate voltage is 100 volts, what will the gain be for an assumed amplification factor of 20 and a plate load of 100,000 ohms? The following formula can be used:

$$V.A. = \frac{G_m R_p R_L}{10^7 (R_p + R_L)}$$

where V.A. = voltage amplification  
 $G_m$  = mutual conductance in mhos  
 $R_p$  = plate resistance of tube (plate volts/plate current)  
 $R_L$  = load resistance.

Then, substituting in the formula,

$$\begin{aligned} V.A. &= \frac{2,000 \times (100/.001) \times 100,000}{10,000,000 [(100/.001) + 100,000]} \\ &= \frac{2,000 \times 10^{10} \times 2 \times 10^{13}}{10^7 \times 200,000 \times 2 \times 10^{12}} \\ &= \frac{1 \times 10}{1 \times 10} = 10 \end{aligned}$$

Or, the following formula can be used:

$$V.A. = \frac{M R_L}{R_L + R_p} = \frac{20 \times 100,000}{100,000 + 100,000} = 10$$

where M = amplification factor of tube, obtained from tube chart.

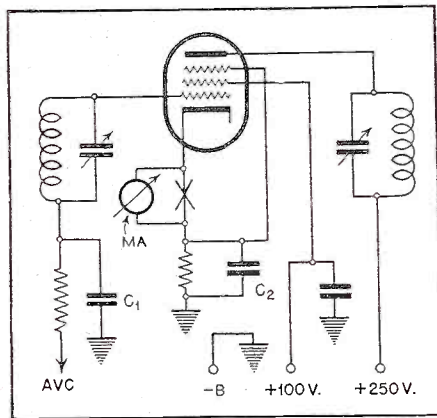


Fig. 3. The millimeter indicates the plate and screen current by means of the cathode current.

These calculations need not be performed in most cases but come in handy at times. As a more practical problem to be solved, let's take the case of an ordinary signal generator. For alignment work it is essential that a good signal generator of high accuracy be on hand.

### Aligning Short-Wave Bands

The alignment of a superheterodyne on the broadcast band is comparatively simple but a good job on the short wave bands is not so easy. In the past, many servicemen have not worried too much about short wave alignment because poor reception could always be blamed on "conditions" and they could get away with it. But today many people are interested in short wave and want their receivers to operate properly. Of course, *only American citizens may have such sets*. In order to align the circuits accurately, the average serviceman's generator is not accurate enough to do the job unless it is checked against a standard station. A practical procedure, instead of buying a crystal oscillator, which is expensive, is to zero beat the 1,000 kc. output of the generator against a standard broadcast station. The station is tuned in and the generator, in the unmodulated position, is tuned close to the station frequency. As you get close to the station a heterodyne is heard which is somewhat high pitched. Then you approach the point where a very low frequency sound is heard. Continuing on you hear the low frequency sound again. In between, where no sound or zero beat is obtained, is the correct position of the generator signal.

The 1,000 kc. fundamental will give strong harmonic signals up to about 20,000 kilocycles. From there on you must use 5,000 kc. as the fundamental for good results. Then, in calibrating an F-M receiver, you

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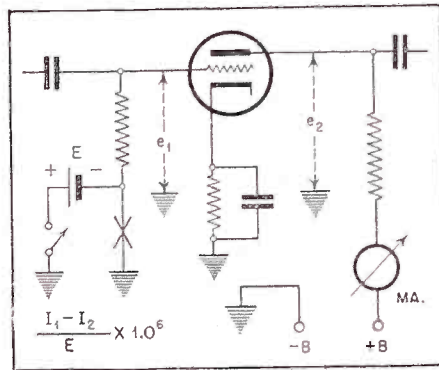


Fig. 4. A simple but old method of testing tubes when a regular tube checker is not available.

# TECHNICAL SERVICE PORTFOLIO

## SECTION XXV

### MODERN P. A. AMPLIFIER DESIGN PRACTICE

**M**ANY servicemen who are competent to repair or adjust even the most complicated radio receivers run into difficulties when working on public-address amplifiers. Yet the circuits in the latter are fundamentally far more simple than many which are encountered in modern radio receivers. Difficulties arise principally, we believe, because the average serviceman just hasn't bothered to familiarize himself with the circuits and peculiarities of high-gain audio amplifiers. Generally such amplifiers are purchased rather than assembled by the user, not so much because they are so difficult to manufacture, (they aren't), but because a professional appearance is essential in any apparatus

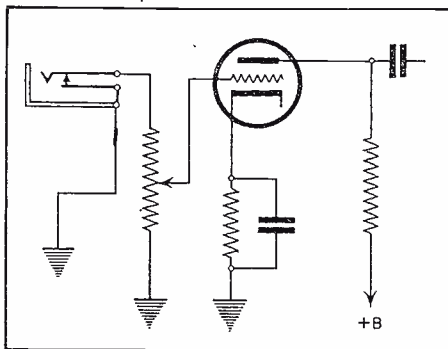


Fig. 1. This type of input circuit is employed only when using phonograph pickups or microphones with very high output.

which is to be exhibited to the public and this cannot be obtained economically except in quantity production. And because these manufactured amplifiers have given surprisingly reliable service, considering their cost, it hasn't been necessary to learn the details of their design in order to handle the more usual repairs which are likely to be required.

#### Amplifier Modification

Now that it is no longer possible to replace amplifiers which develop serious troubles, because most manufacturers are now engaged solely in war work, a great many amplifiers which would normally be retired from service will require repair. In fact, we are going to have to put back in service many antiquated amplifiers which, in normal times, would be junked. Some will need rebuilding in order to provide sufficient gain for modern microphones or to improve their performance. Modern amplifiers, as we shall see, are much simpler than some of the older types, and we shall often find that it pays to spend a little time and effort in modernizing some of these older instruments. For modern design improvements make possible the greater gain, power output and lower hum level, required to meet present-day needs, and can be effected often with but little difficulty.

Many of the older, relatively low-gain p.a. amplifiers were designed for use with carbon microphones and, when less sensitive mikes were employed, such as the condenser type, made use of pre-amplifiers. Now, at least for p.a. work, the pre-amplifier is a rarity. The input circuits of such low-gain amplifiers were often designed along the lines of audio amplifiers in radio receivers. The volume control was placed right in the input circuit, as shown in *Fig. 1*. With the advent of high-gain tubes and resistance-coupled stages, concurrently with the wider use of less sensitive but better fidelity microphones, the volume control was moved to the second stage input,

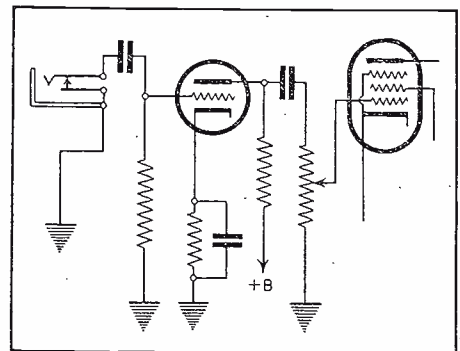


Fig. 2. In high-gain amplifiers for modern microphones, the volume control must be placed in the second stage input.

age developed across the junction of these two resistors is 7000/257000th (about 1/36th) of the total grid voltage applied to the upper tube grid. When this signal voltage is amplified 36 times by the remaining section of the 6SC7, we see that the resulting signal voltage applied to the lower output tube grid is the same as that for the upper tube grid. However, the phase is reversed so push-pull operation of the output tubes is obtained. This circuit is not as good as the preceding one, with respect to uniformity of performance, since the analysis shows that proper operation depends upon the gain of the tube remaining constant and at a fixed value, while the preceding circuit operates properly no matter how much the gain varies. However, the high gain of the circuit of Fig. 7 has made it a favorite and, practically speaking, a surprising amount of unbalance due to variation in gain is not detectable by ear.

Tone control is usually incorporated in the input to the last stage. A suitable circuit which will provide considerable reduction in high-frequency response is shown in Fig. 8.

### Resistance-Capacitance Filtering

One innovation which is coming into quite general use, and which offers a welcome saving in weight of portable or semi-portable p.a. amplifiers is the substitution of resistance-capacitance filtering in the power supply for the more usual choke-and-condenser combination. A typical arrangement of this type is shown in Fig. 9. Note that the output tube plates are fed directly from the start of the filter circuit, thus avoiding the high voltage drop which would otherwise result if the connection of the output transformer were made after the 2000-ohm filter resistor. The only filtration for the output plates is that provided by the 16-mfd condenser from rectifier filament to ground. This type of circuit is practical only with push-pull output tubes, because the hum voltage applied to the output tubes is opposite in phase and tends to cancel out. Perfect cancellation is not obtained, however, because no two output tubes are identical. Some hum always remains, but this is reduced because the output voltage is stepped down by the output transformer. Looking at it another way, the signal voltage is always greatest at the output tube plates; therefore the ra-

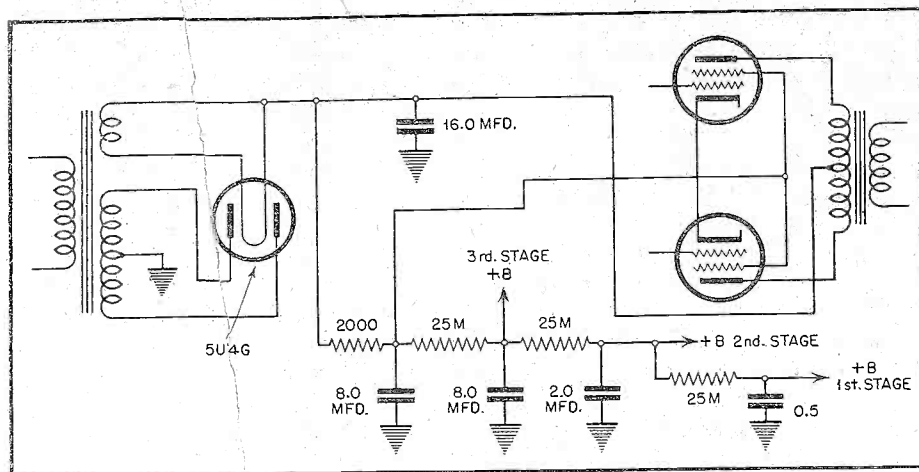


Fig. 9. Chokes are supplanted by resistors in the filter circuits of this power supply, thus saving weight and space.

tio of the signal voltage to the hum voltage will be greatest when whatever hum is introduced arrives in the output plate circuit. The hum level in any p.a. system is always expressed as a ratio of maximum signal to hum, because the hum will then be blanketed by the signal.

### A.C.-D.C. Circuits

Often it is desirable to operate a p.a. amplifier from either a 6-volt d.c. source or from 115 volts a.c. An amplifier which is designed to operate from either of these sources is shown in schematic form in Fig. 10. As illustrated, a motor-generator supplies power for 6-volt operation, while the conventional power supply is available for 115-volt a.c. supply. This amplifier is the Lafayette Model 458 DeLuxe Mobile type. The rated power output is 30 watts; the gain of the microphone channels is given as 130 db, and of the phonograph channels as 90 db.

In Fig. 10, the two 6J7 tubes serve as individual first-stage amplifiers for the two microphone inputs. The mixing of these two inputs (and of the phono input which is joined to one of the microphone first-stage output channels) is accomplished electronically by means of the 6C8G dual triode. Note that the top 6J7 is coupled to one grid of the 6C8G while the lower 6J7, along with the phono section, joins to the remaining 6C8G grid. The 0.25 megohm resistor in series with the phono volume control serves to minimize the reaction on the mike control which would otherwise result when this control is adjusted, or vice versa.

The plates of the 6C8G electron mixer are joined in parallel, and are

coupled by means of the 10,000-ohm load resistor to one grid of the next 6C8G, which is used as a phase inverter. The 5-megohm control in series with the 0.1 mfd condenser, shunted across the .001 mfd condenser in this coupling circuit forms a treble boosting device. When the moving arm of the 5-megohm potentiometer is so adjusted that all the resistance is in the circuit, the high frequencies are by-passed around this potentiometer, while the low frequencies are attenuated. Thus the high frequencies reach the phase inverter grid with but little attenuation and are consequently stronger in proportion to the lower frequencies than they otherwise would be. So treble emphasis is thus obtained. The 0.25 megohm control, to which the 0.1 bypass is connected, forms a conventional bass control, which emphasizes the bass by attenuating the treble.

The operation of the phase inverter in this circuit is similar to that described before, and illustrated in Fig. 7. Since the plate load in the

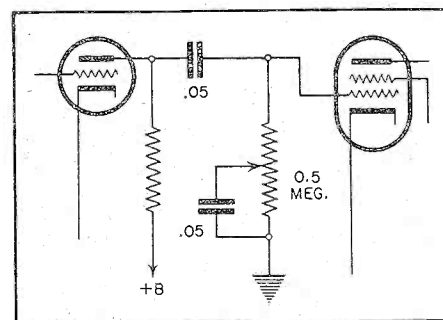


Fig. 8. This phase inverter circuit gives considerable gain as well as phase inversion.

circuit of Fig. 10 is 0.1 meg while that in Fig. 7 is 0.25 meg, there is less gain in the circuit now under discussion. Thus we find that the divider circuit in the 6E6 input grid is here composed of 0.25 meg in series with 10,000 ohms, instead of 7,000 ohms, as in Fig. 7. The gain of this circuit is thus estimated at 26.

The high power output obtained with this compact amplifier is secured by using a Class B output stage, consisting of two 6Y7G's. For mobile applications, the slight additional distortion which results when Class B operation is employed is more than compensated for by the high efficiency of this form of power amplification.

### Eliminating Hum

In using any high gain amplifier, one of the most frequent causes of unsatisfactory operation is excessive hum. In most cases, this trouble is not caused by any fault in the amplifier design, but rather to improper or careless use of the mike or its associated cable and coupling medium. It is absolutely essential that every point between the grid of the first

tube in the amplifier and the microphone itself be completely shielded. With crystal and other non-magnetic types of microphones, this is not difficult. We must make sure that a shielded plug is used, that the microphone cable shield is continuous, with no bare spots or breaks, and that it connects to the ground of the amplifier chassis. Grounding all along the line is important. Sometimes it is found that a reduction in hum is obtained when the a.c. power plug for the amplifier is reversed in the wall connection. There are times when an external ground, connected to the amplifier, reduces hum; sometimes it makes it worse. If there is no bottom cover on the amplifier, hum pickup may result; likewise if the input tube grids are unshielded.

With magnetic types of microphones, or with other types if a coupling transformer is used, it is essential to keep the microphone and its coupling transformer well away from the amplifier, particularly from the power transformer. With very sensitive amplifiers, hum pickup will result due to electromagnetic coupling even though the coupling transformer and power transformer in

the amplifier are several feet apart. Usually, though, the mike or transformer may be turned in such position that minimum coupling, and consequently minimum hum, results. Of course, nearby electrical machinery of any type creating an external field will likewise induce hum in the manner just described.

Most amplifiers are equipped with many taps on the output transformer secondary, so that a variety of output impedances are available. Sometimes it is a problem to decide just which ones to use, when it is possible to match the impedances by connecting voice coils in series or in parallel, or by selecting any pair of a variety of taps on the coupling transformer associated with the speaker. For long lines, say from 50 to 500 feet, it is fairly standard to use a 200-ohm or 500-ohm line. In such cases, the output tap on the amplifier is connected to the corresponding input tap on the speaker transformer. For short lines, the speaker voice coil may connect directly to the output transformer secondary of the amplifier. If the line is long, and the speaker voice

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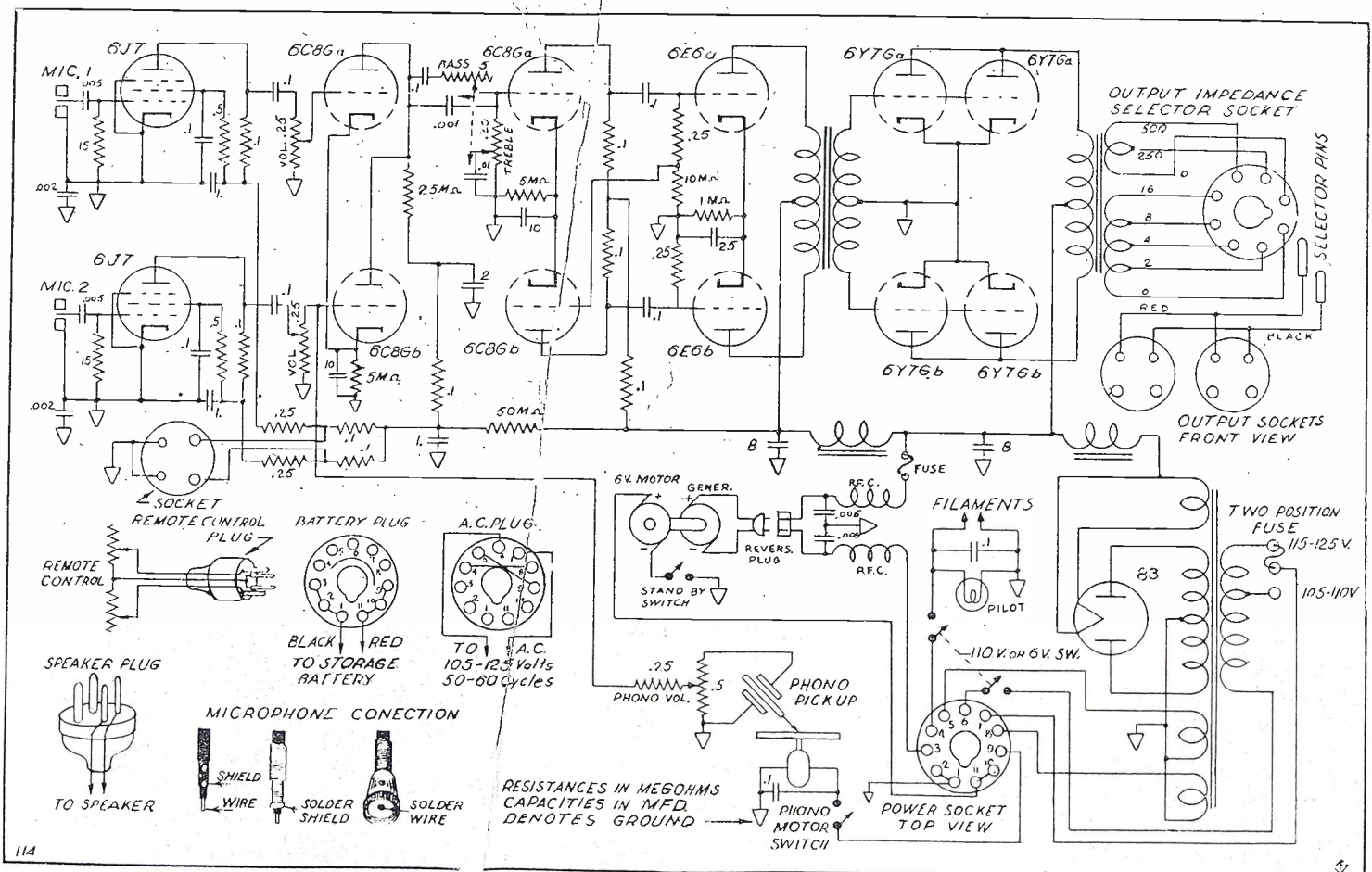


Fig. 10.-A complete schematic of the Lafayette 30 watt Type 458 Mobile Amplifier.

## CHOOSING A MICROPHONE

(Continued from page 8)

transmission line. Such a line may be useful when it is necessary to avoid stray pickup in strong electric fields, which are hard to shield against when a high-impedance line is used, as would otherwise be required in connection with the crystal mike.

### Condenser Mikes

Condenser mikes are not often used in field radio work nowadays, partly because of their low sensitivity in comparison with other present-day high-impedance microphones, and partly because of the precautions which are necessary in their handling and application. In the condenser mike, an extremely light dural diaphragm is placed close to, and insulated from, a back plate of substantially the same shape and physical dimensions. Thus these two plates form a condenser. To the diaphragm is applied a polarizing potential, often as high as 500 volts. When sound waves strike the diaphragm they cause it to vibrate, thus varying the capacity between the diaphragm and the back plate. This variation in capacity varies the voltage across a resistor placed in series with the polarizing voltage source, by varying the electric charge on the condenser. The varying voltage across the resistor is applied to the input circuit of a high-gain amplifier.

Because of its extremely high impedance and relatively low sensitivity, it is necessary to use a pre-amplifier in conjunction with condenser mikes. Often the pre-amplifier is built right into the microphone housing. This is desirable, because the capacitance of the leads must be kept at a minimum, otherwise the sensitivity of the mike will suffer. After the pre-amplifier raises the mike voltage appreciably, the output signal is fed to the main amplifier. Although the condenser mike is highly desirable because of its excellent fidelity, the complications of the polarizing voltage source, which must be either pure d.c. or from an extremely well filtered power supply, plus the need for a pre-amplifier, have limited its applications to studio work and to special work in the sound measurement field.

### Velotron Mikes

One type of mike which has been widely used is a combination of rib-

bon and condenser mike, in which a charged and insulated plate is employed in conjunction with thin strips of dural which serve to vary the electrostatic field when actuated upon by sound waves. This mike has many of the advantages of the condenser type plus considerably greater sensitivity. Two types are available; one which requires a polarizing voltage supply and another which does not. This variety of microphone is known as the Velotron. Because of its high sensitivity, less gain is required in the amplifier and the polarizing voltage, if re-

is determined from the formula

Microphone rating in db = 20 log<sub>10</sub> E<sub>o</sub>/1 volt per bar where E<sub>o</sub> is the open-circuit output voltage.

We might digress for a moment to tell what is meant by "open-circuit" output voltage. This is the voltage across the microphone output terminals, when it is connected to no load. That is, as measured with a high-input impedance device, such as a vacuum tube voltmeter. If there is a transformer built into the mike housing, this is the voltage across the transformer terminals, not across the mike element. Usually, if

TABLE I.

Type of Microphone	DB Rating	Impedance (ohms)
Velocity (P.A. Types)	-56 to -70	200-2000
Velocity (Broadcast)	-74 to -100	250
Dynamic	-88	20
Crystal	-46 to -86	*High
Carbon	-40 to -55	100-400 ohms

\*Over 150,000 ohms at 400 cycles

quired, need not be so completely filtered. These mikes are extremely directional and may be operated within a few feet of the reproducing speaker without feedback, provided care is taken to put the mike at such an angle with respect to the loudspeaker that no sound waves impinge directly upon the mike.

### Rating Mikes—the Bar

Microphones are rated on their open-circuit output voltage for a given sound pressure input. Sound pressure is expressed in terms of dynes per square centimeter, and a sound pressure of one dyne per square centimeter is conveniently designated as a bar. A sound pressure of one bar is equivalent to that produced when a person speaks into a microphone at a normal conversational level with the microphone about 10 inches from the speaker's mouth. The reference level upon which most microphone ratings are based is one volt per bar, which means that a microphone which delivers an output of one volt when spoken into at a normal conversational level with the mike 10 inches from the speaker would have a rating of 0 db. Actually, no microphone will deliver an output of 1 volt under such conditions, consequently the rating is always less than 0 db. In general, the voltage output will be of the order of 1 millivolt, which is equivalent to -60db. This db rating

there are taps on the transformer, the output rating is specified as the open-circuit voltage across a 250-ohm line, if the impedance happens to be this value across the taps under consideration. When the mike is actually connected to a properly terminated line, the output voltage will be just one-half, or 6 db less, than the open-circuit voltage. In the case of crystal and other high impedance mikes, or of low impedance mikes working into grid circuits directly, the output voltage will be the same as the open-circuit voltage and consequently the rating will apply directly.

Some microphones are rated on a basis of a 10-bar reference level. This rating may be converted to the more usual 1 bar level by subtracting 20 db from the 10-bar rating. Thus a mike rated at -70 db for a 10-bar reference level would have a sensitivity of -90 db for a 1-bar reference level. It is desirable to make this conversion in every case, otherwise it will lead to difficulties when attempting to use such mikes with amplifiers of limited gain. It is unfortunate that some of the finest mikes do not have greater sensitivity, but such is the case. A tabulation of representative types of microphones and their range of sensitivity is shown in Table I. Note that the ranges given are not for a single type of mike but for the most sensi-

(Continued on page 26)

January to December, Inclusive

ANTENNA		Receiver		INDICATORS	
	Issue Page		Issue Page		Issue Page
<b>Auto</b>		Belmont Model 7D22	May 15	(See "Servicing—Equipment")	
Auto radio antenna check	Mar. 17	Coronado C579	Sept. 13	<b>INSTANTANEOUS RECORDERS</b>	
<b>Loop</b>		Crosley 52-FC	June 18	(See "Recording")	
Aerials; for store demonstration	Mar. 17	Crosley 52-TQ	Apr. 15	<b>INVERSE FEEDBACK</b>	
Altering Enemy Alien Multi-Band Sets	Feb. 4	Crosley 72CA	May 17	Commonly Used Forms of Phase	
Loop Coupling in 1941-42 receivers	Jan. 16	Emerson GH-437 and GH-438	Feb. 15	Inversion	Jan. 17
Loop Receivers: hi-impedance primaries	Mar. 17	GE-LC-679	Sept. 12	Improved frequency response in RCA	Nov. 9
Silvertone 7072 loop receiver	Nov. 9	GE "Musaphonic" Model 35	Apr. 14	552	Nov. 9
Switching of loops	May 17	GE Model 40 "Musaphonic" A-FM	May 16	KP and G—Part III, John F. Rider	Jan. 6
Wilcox-Gay A-105 antenna loop adjustment	Apr. 19	Comb.	Mar. 14	Modern P.A. Amplifier Design Practice	Dec. 12
<b>Television</b>		Motorola 101C31	Mar. 14	Power and degeneration	Jan. 16
Installing Television Antennas	May 6	Pilot A-FM Model T-301	Jan. 8	Practical Negative Feedback	Feb. 11
<b>AUDIO AMPLIFIER</b>		RCA 15X, 36X	May 18	Spring Cleaning—1942, by John H. Potts	Mar. 7
<b>Circuits</b>		RCA VHR-212	June 18	<b>MICROPHONES</b>	
Adding Earphones for Profits, by Willard Moody	Oct. 10	RCA Model 26BP	Apr. 16	Choosing a Microphone, by John H. Potts	
Class AB 1 amplifiers	Jan. 16	RCA Radiola 552	Nov. 10	Modernize Sets by Adding Recorders, by Willard Moody	Aug. 9
Class B amplification	Jan. 16	Silvertone 101.660	Apr. 15	<b>PHONOGRAPH</b>	
Dual Speaker set phasing	Mar. 26	Silvertone 7057	Mar. 28	Compensation	
Eliminating hum in amplifiers	Dec. 18	Silvertone 7072	Sept. 13	(See "Tone")	
Lafayette Mobile Amplifier	Dec. 18	Silvertone 7099 SW-A-FM	Nov. 12	Record Changers	
Modern P.A. Amplifier Design Practice	Dec. 12	Silvertone 7167	Nov. 12	Crosley NP-358 Record changer adjustments	
More on Transformer Substitutes, by H. F. Gulliver	Sept. 16	Ward Model 24BR-914A	June 20	Farnsworth P-32: service notes	
Phase Inverters	Jan. 7	Wilcox-Gay A-106 F-M Receptor	Mar. 13	GE LRP-32: service notes	
Phase Inverters	Jan. 17	Wilcox-Gay Models A-113, A-114, A-115	Apr. 13	RCA RMP-110: record changer adjustments	
Practical Negative Feedback	Feb. 11	Zenith (22B1 chassis) A-FM receiver	Mar. 10	RCA RP-151 Record Changer Adjustments	
RCA VHR-212: phono-radio-recorder	June 18	<b>CIRCUIT COURT</b>		Silvertone Automatic Record Changer	
Servicing by Signal Injection, by John H. Potts	Sept. 6	AC-DC Electric Phonograph	Apr. 15	Wilcox-Gay "Insta-Matic" Record Changer	
Some AC-DC Design Problems, by John H. Potts	Apr. 5	AC-DC Phono-Radio	Feb. 15	Recording	
Transformers—"The Untouchable," by Warren A. Anderson	June 5	Antenna Wave Trap	Feb. 16	Modernize Sets by Adding Recorders, by Willard Moody	
Wireless phono-radio-recorder	Mar. 27	Audio regeneration	May 15	<b>Record Players</b>	
Zenith 22B1 Power Amplifier	Mar. 10	Bass reactor	Jan. 20	Emerson Phono-Combination	
<b>BATTERY OPERATION</b>		Bias Control tube	Jan. 20	<b>PICKUPS</b>	
Crosley 52-FC		Bleeder bias	Jan. 19	<b>General</b>	
Improvements in circuit design		Cathode coupled oscillator	Sept. 12	Unaccountable Distortion in Crystal Pickups	
Locating Interference with RCA BP-10		Cascade Limiter	May 16	Soldering leads to Crystal cartridges	
RCA Model 26BP		Composite tone control	Jan. 19	<b>Compensation</b>	
Apr. 16		Crystal Pickup Response	Feb. 15	Crystal Pickup Response	
Silvertone "Powr-Shift"		Eliminating feedback	June 18	Phono Compensation with series Equalizer	
Mar. 5		F-M Alignment	Mar. 13	Phono Compensation with shunt Equalizer	
<b>BIASING</b>		F-M Carrier Systems	Mar. 10	RCA VHR-212: Compensation to prevent feedback	
A-F and 1-F contact-potential biasing		Gas gate	Jan. 20	Record player attachment tone compensation	
Jan. 16		Grid bias in Silvertone 7167	Nov. 10	Shunt and series pickups equalizers	
Bias control in Silvertone 7167		High gain portable	Apr. 16	<b>PUBLIC ADDRESS</b>	
Nov. 10		IF-AM Bias	Apr. 16	Choosing a Microphone, by John H. Potts	
Bias in Silvertone Model 7189		Loop preselector	Jan. 20	Industrial Sound Installations	
Sept. 11		Loop Transformer	Feb. 16	Lafayette Mobile Amplifier	
Bleeder Bias in Power amplifiers		Negative bias on suppressor of 6SK7	Sept. 13	Modern P.A. Amplifier Design Practice	
Jan. 19		Oscillator-Converter	May 16	<b>RECORD CHANGERS</b>	
Gas Gate		Oscillator Core Adjustment	Feb. 16	(See "Phonograph")	
Jan. 20		Oscillator Coupling	Mar. 29	<b>SERVICING</b>	
IF-AM Bias		Phono Circuit of GE Model 35	Apr. 13	<b>Equipment</b>	
Apr. 16		Phono compensation circuit with series Equalizer	Nov. 8	The A.C. Meter	
KP and G-Part III by John F. Rider		Phono compensation circuit with shunt Equalizer	Nov. 8	About Tube Checkers	
Jan. 6		"Powr-Shift"	Nov. 11	Aerovox 75 Capacity-Resistance Bridge	
Metering Miracles, by L. R. Byron		Selective Regeneration	Feb. 16	A satisfactory VTVM	
Dec. 10		Self & Semi-Fixed Bias	Feb. 31	Design and Maintenance of Ohmmeters	
Modern P.A. Amplifier Design Practice		Speaker resonance curvers	Sept. 17	Milliameters	
Dec. 12		Station Silencer	May 16	Noise Generators in Servicing, by John H. Potts	
Phase Inverters		Variable bass-treble tone control	May 17	Servicing by Signal Injection, by John H. Potts	
Jan. 17		Wireless phono-radio-recorder	Mar. 28	Servicing Your Signal Source	
RCA VHR-212: biasing 6K6GT tubes		<b>COILS</b>		Solar CE Exam-Eter	
June 18		"Q" in coils, etc.		Oct. 13	
Self and Semi-Fixed Bias		Repair Rather than Replace, by H. F. Gulliver			
Feb. 31		Sept. 6			
<b>BOOK REVIEW</b>		<b>CONDENSERS</b>			
Automatic Record Changers and Recorders, by John F. Rider		Modern Slants on Intermittents, by John H. Potts			
Jan. 5		More on Transformer Substitutes, by H. F. Gulliver			
1942 Replacement Vibrator Guide, by P. R. Malloy & Co.		"Q" in coils, etc.			
May 29		Saving Condensers			
MYE Technical Manual, by P. R. Malloy & Co.		Testing Condensers			
Dec. 28		<b>ELECTRONIC APPLICATIONS</b>			
<b>BUSINESS ARTICLES</b>		Electronic Equipment—Sales & Service			
Adding Earphones for Profits, by Willard Moody		Industrial Electronics—sales & Maintenance			
Oct. 10		Vigilance for Victory			
Altering Enemy Alien Multi-Band Sets		<b>COMPENSATION</b>			
Feb. 4		(See "Tone Compensation")			
A Practical Pricing Method		<b>FREQUENCY MODULATION</b>			
Apr. 22		Circuits			
A Slant on Collections, by B. V. Selle		Pilot A-FM Model T-301			
May 8		Silvertone 7099: SW-AM-FM			
Increase Your Net on Each Job		Wilcox-Gay A-106 F-M Receptor			
Apr. 20		Zenith A-FM (chassis 22B1)			
Industrial Sound Installations		General			
June 28		GE-LF 115 and 116 alignment data			
Modernize Sets by Adding Recorders, by Willard Moody		Simplified 1941 design of F-M			
Aug. 8		Testing & Aligning F-M Receivers			
OPA Price-fixing Order Analyzed		Apr. 9			
May 7					
Thinking Ahead on Servicing, by J. J. Kahn					
Nov. 13					
"Too Little-Too Late"					
July 3					
"Victory Dinner"					
July 14					
Vigilance for Victory					
Jan. 4					
<b>CIRCUITS</b>					
(Also see "Circuit Court")					
<b>Audio</b>					
See ("Audio Amplifiers")					

see C. Here, the lowest frequency signal is also obtained with maximum padder capacity and we always start from maximum capacity and work out. We select the second peak. On broadcast we select the first peak in making adjustments, since the oscillator is to be aligned on the high side of the signal.

The sensitivity of the set should be checked by running the signal generator dial in step with the receiver dial and noting any wide change in output as this is done. It takes a little practice to get the hang of turning the generator dial with the left hand while moving the receiver dial with the right, but it is a useful test. In this way, dead spots are found. Some receivers are so poorly designed that absorption takes place and there is nothing you can do about the dead spots due to coils being crowded into spaces where an ant would need to wriggle to get through. But the manufacturers don't build commercial brand radios to have perfect short wave

the jobs which require skill and labor rather than material. The data given here, it is hoped, will help you do just that.

★

## The Tube Situation

The critical shortage of replacement tubes is apparent to all Service-Dealers and Jobbers. On November 27th the Crosley Corporation of Cincinnati sent a letter to all their distributors. We reprint that letter in full that all "RSD" readers may

have a clear picture as to how matters stand.

TO ALL CROSLY DISTRIBUTORS:

Many Crosley distributors are having difficulty obtaining radio tubes. This letter has been prepared to assist in this problem.

All radio tube manufacturers have on hand government orders many times their maximum peace-time production. As a result but few civilian types of tubes are being manufactured and many tube models are becoming very scarce. Government release on additional civilian tube manufacturing has been very slow due to their inability to determine exactly the number of tubes

(Continued on page 25)



## "Of Course, I'd Rather Use My Car

★

... but if the boys in the service need the gas, I'm satisfied to do with less".

People have willingly given war needs a priority over civilian desires.

★

If you explain to your customers why radio parts are scarce—and how you licked an "impossible" situation to get their sets operating at all—they will accept those repair jobs that may be "a little less than perfect."

★

Naturally, you don't like to work on the antiquated sets you're getting today—especially with the shortage of men and materials. But, it's your patriotic duty to keep 'em playing—even if you have to improvise repairs. Of course, to do this efficiently you must know exactly *what's inside the set*.

★

That's where Rider Manuals save you time. They lead you right to the cause of failure and furnish you with the facts that speed repairs.

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So, don't waste time "guessing out" defects and "experimenting" with possible methods of improvising repairs. Reach for one of your thirteen Rider Manuals when you begin *every* job. It's good sense and good citizenship to work efficiently today. It conserves parts and saves labor—both critically scarce right now.

★

★

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**YOU NEED ALL THIRTEEN  
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★

★

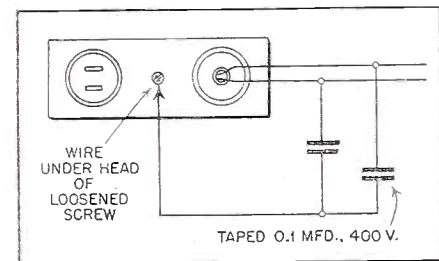


Fig. 6. A simple line filter.

response although many of them are pretty good. So just keep that point in mind before deciding your alignment job is not the best that can be done. For example, in tuning the dial of a typical set from 6 megacycles to 20 megacycles it was found that dead spots occurred 12 to 14 and 9-10. Moving a hunk of paper condenser out of the field of one of the short wave coils cleared up the condition.

### Noise Filters Help

Surprisingly enough, a line noise filter seems to work very well on short wave, even better than on broadcast, and to boost signal strength. It may consist of two condensers, so arranged that each side of the power line input to the radio is by-passed to ground. The ground connection may be on the wall plate of the electric outlet and should be short and direct. This is shown in Fig. 6.

Profits in servicing these days are greatest when you go after and do

## MODERN P.A. AMPLIFIER DESIGN PRACTICE

(Continued from page 18)

coil resistance is low, it is possible that considerable power will be lost in the line when this method of connection is used, due to the resistance of the leads.

When several loudspeakers are being used, it is essential that their voice coil impedances be identical if they are to be connected in series or parallel. If not, separate coupling transformers, with primary impedances of identical value—generally 200 or 500 ohms—should be employed. If four speakers are being

used, with 500-ohm coupling transformers, they may be connected in series-parallel to provide an impedance which remains at 500 ohms for coupling to the output transformer of the amplifier. When the taps on the output transformer do not match any of the impedance values of the speaker transformer or voice coil, it is better to connect to a tap of lower impedance rather than of higher impedance, for minimum distortion. In general, considerable mismatch is possible before noticeably bad results are obtained, so don't be too academic about it.

### Feedback

Acoustic howl due to feedback is one of the most common annoyances

encountered in p.a. work. The remedy, of course, is to keep the reproduced sound from the loudspeaker from getting back into the amplifier input circuit via the microphone, but there are times when this is none too easy. The first step is to place the loudspeakers in such manner that reflection of the sound back of the mike is at a minimum. When this is difficult or impossible, the next best method is to shield the mike acoustically. This is accomplished by placing it in a box padded with sound absorbent material, such as cellotex. A small hole is cut in the box to speak into. This arrangement affects the fidelity somewhat, though not as much as one might expect, but does eliminate acoustic feedback.

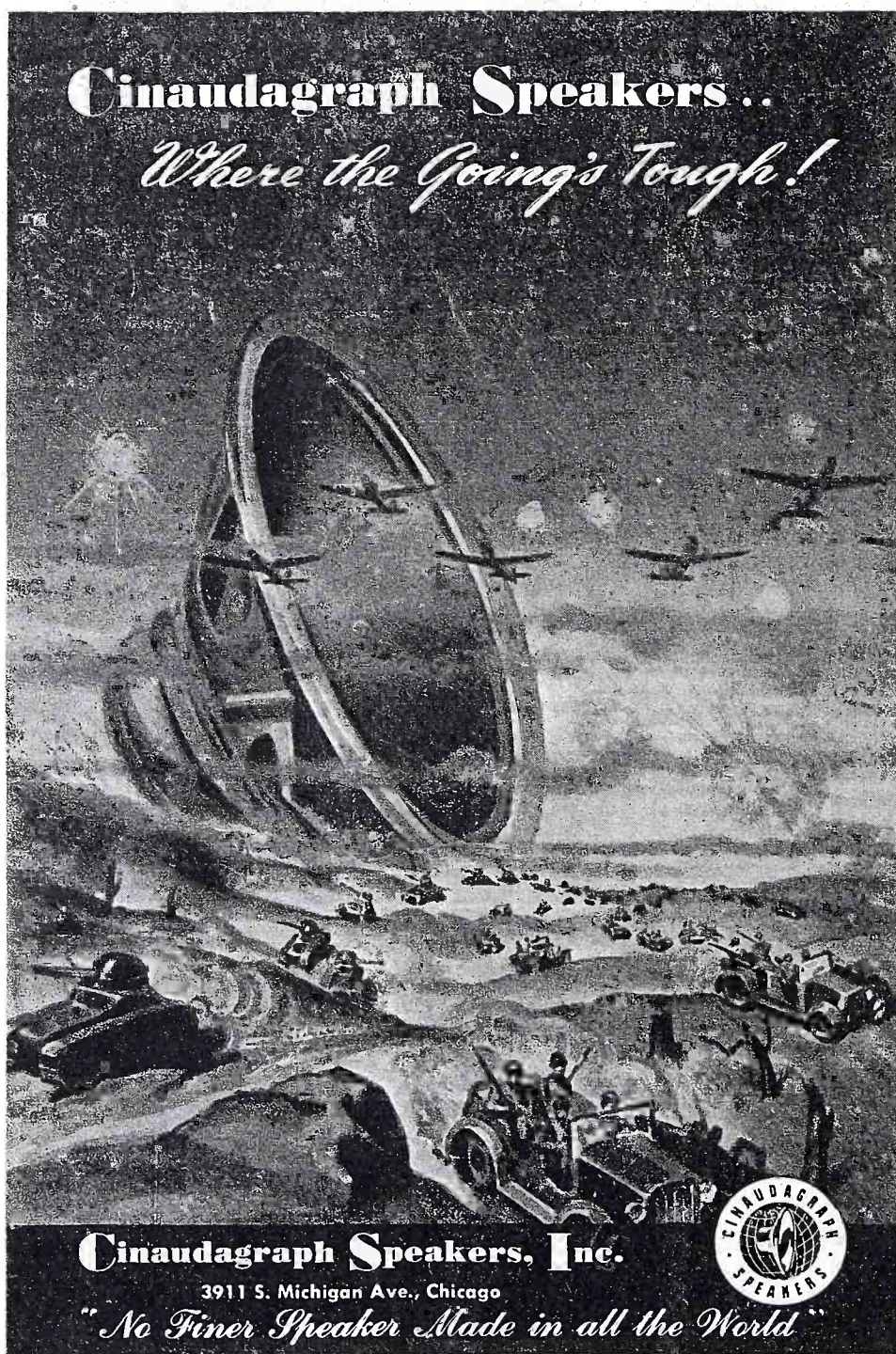
### Trap-Circuits

Some microphones are more subject to trouble with acoustic feedback than others. This is the case when a resonant peak is present in the mike response curve. The same effect is caused, and more frequently, by peaks in the loudspeaker response. This effect can be noted by taking cognizance of the howl frequency. If a trap circuit is introduced—simply an iron-core choke and condenser in series—across the grid circuit of one of the amplifier stages, this peak may be greatly attenuated so that the microphone may be used closer to the speaker. The values of choke and condenser may be varied until the desired frequency is obtained. This is facilitated by using a calibrated audio oscillator to determine the frequency, whence it is possible to compute the required values of capacitance and inductance for the trap circuit.

Placing the microphone in another room, totally shielded acoustically from the loudspeakers, or well back on a stage, with the loudspeakers set in the walls in front and at each side of the stage, are methods frequently used to minimize acoustic feedback. When the operator of the amplifier is not in the audience, it is somewhat difficult to gauge the required volume level. This is best determined by test beforehand, noting the level on an output meter connected across the amplifier output when an assistant advises that the level is satisfactory. This may then be maintained during the performance.

Volume compressors and expanders have advantages in many p.a. applications. However, these circuits are rather involved and are therefore being considered in a separate article to follow.

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## THE TUBE SITUATION

(Continued from page 23)

on hand for all distributors or accounts. We can, therefore, expect but little relief during the next few months.

There are tubes available, however, each tube manufacturer does not have all tubes and certain tubes are not available at all. Tube characteristics are such that your radio service man can make many tube substitutions by slight changes in the circuits, which do not affect the set's performance. Tube data sheets, which various tube manufacturers have supplied and are still able to supply, furnish this information.

To obtain tubes, it is first necessary that a PD-1-X, properly filled out, is presented to the War Production Board. The following instructions, if carefully followed, will assist you in obtaining priority assistance.

1. Use a separate line for each tube model number. Enter the tube model number in Column B.
2. In Column C, enter your physical inventory, as of December 31, as closely as possible in dollar value.
3. In Column D, enter your receipts of the particular model tube from January 1 to date of filing the PD-1-X. Remember that if a PD-1-X form is entered Dec. 1, 1942, the amount shown in Column D is for eleven months, and 1/11 of this amount will represent to the War Production Board your monthly purchases.
4. Column E is to show your inventory for each model as of the filing date. In handling your application, the War Production Board will add together Column C and Column D, and subtract from this Column E, to determine usage for the period covered. Again, considering eleven months, your monthly usage would be taken as 1/11 of this amount, that is, Column C, plus Column D, less Column E. The amount which you can request in Column F will be  $1\frac{1}{2}$  times this figure. If anymore is requested, it will be denied.
5. Column A can then be filled out with a quantity, the cost of which will be equal to the value determined in Column F.

The handling of the PD-1-X form by the War Production Board is on the basis of simple arithmetic, as shown above. If the result of the arithmetic shows a request for more than a  $1\frac{1}{2}$  month's supply, the request will be denied. The amount of time and effort necessary to obtain priority assistance by means of this form can be greatly reduced by paying careful attention to the above instructions.

After obtaining approval and a priority rating of A-3, or better, tubes may be ordered from anyone of the following companies:

Hytron Corporation, Salem, Mass.  
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.

National Union Radio Corp., Newark, N. J.

Raytheon Production Corp., New York, N. Y.

RCA Manufacturing Co., Inc., Camden, N. J.

Standard Arcturus Corp., Newark, N. J.

Sylvania Electric Products, Inc., Emporium, Pa.

Tung-Sol Lamp Works, Inc., Newark, N. J.

If certain tubes cannot be obtained from your regular source of supply or anyone of the above listed companies, do not hesitate to try another supplier. It is a strict ruling from the War Production Board that manufacturers hav-

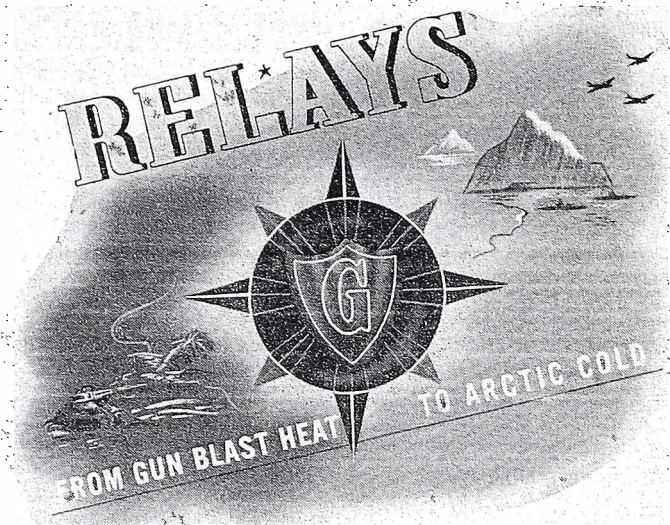
ing replacement tubes available must accept and fill orders according to priority rating, regardless whether or not previous purchases have been made by the customer. If any manufacturer should refuse to ship because they have not furnished you tubes in the past, advise Mr. Frank MacIntosh, War Production Board, Room 4320, Social Security Bldg., Washington, D. C.

We sincerely hope that the above information will be of assistance to you in obtaining those radio tubes necessary to continue your radio service operation.

(Signed)

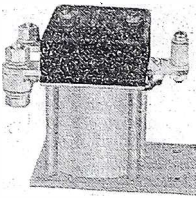
H. A. Newell  
General Service Manager,  
The Crosley Corporation

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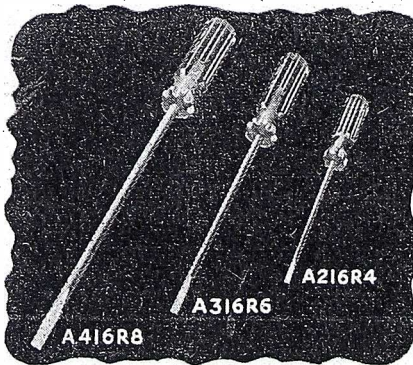
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## CHOOSING A MICROPHONE

(Continued from page 19)

tive and least sensitive in each category. These ratings, it must be emphasized, cover only the range of sensitivities among various models of each type. They have no bearing on the relative fidelity except, as we have pointed out before, that the less sensitive are generally better insofar as fidelity is concerned. This point is of importance mainly in broadcast work; in ordinary p.a. work, fidelity is not so very important.

### Determining Amplifier Ratings

Since the sensitivity of microphones is inseparably tied up with that of the amplifier with which it is to be used, it is perhaps well to discuss here the method of determining amplifier ratings too, particularly as an article on amplifiers (the "TECHNICAL SERVICE PORTFOLIO") is also included in this issue. Amplifier gain may be found from the formula

- (a) Amplifier gain (in db) =  $10 \log \frac{\text{Output Power}}{\text{Input Power}}$
- (b) Amplifier gain (in db) =  $10 \log \frac{\text{Output Voltage}^2 / \text{output load in ohms}}{\text{Input Voltage}^2 / \text{input load in ohms}}$
- (c) Amplifier gain (in db) =  $20 \log \frac{\text{input voltage}}{\text{output voltage}} \text{ plus } 10 \log \frac{\text{input load}}{\text{output load}}$

Although these three formulas all give the same result, in practice it will save time to use the one most suited for the amplifier at hand. If the amplifier has a transformer-coupled input—and there are not many of this type used for p.a. work—we need simply consider the power in the 500-ohm line, or what ever is used in the input circuit—and the equivalent impedance of the output circuit. Thus, if the input and output impedances are identical, we find that in formula (b) we may forget about the input load and output load part of the formula and express the ratio in db based simply upon the measured output voltage squared and the measured input voltage squared.

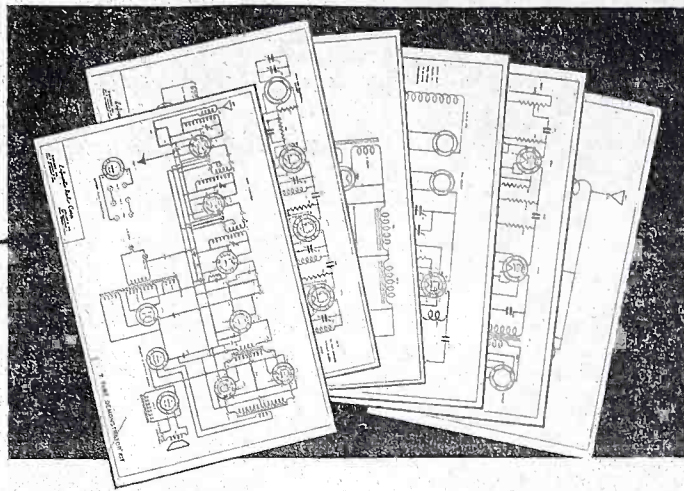
With amplifiers having a high impedance input, such as the unadorned grid input with only a 2-megohm leak from grid to ground in the circuit, the matter of obtaining a

power ratio leads us into difficulties. For, if the 2 megohm resistance is replaced by a 20-megohm resistor, the gain of the amplifier will not be increased in the slightest degree, yet the ratio of output power to input power will be greater. This formula (a) will not work in such instances. This should be qualified by stating that the formula applies only in such cases where the microphone impedance equals that of the input resistor employed. Because the amplifier resistance will always be much higher than the impedance of the mike, the gain will be the same no matter whether the input resistor is 2 megohms or 20 megohms. Because of this anomaly, it is now customary to state in the amplifier rating just what input resistance is assumed in making the calculations. Usually this is specified as 150,000 ohms. Actually, the resistor used is always higher than this value.

A much better form of rating amplifiers is to specify the voltage input required for full output. If for instance, we know the microphone rating to be -60 db, then we also know its output (open-circuit) is 1 millivolt for a sound pressure of 1 bar. If we have an amplifier which will deliver full rated output for 1 millivolt or less input, then we may rest assured that it has adequate gain for the microphone we have in mind, rated at -60 db. Otherwise we will have to calculate the voltage which will appear across the amplifier output load when operating at full rated output, determine the input voltage on the basis of the microphone output, and taking into consideration the load of the amplifier input circuit, and consider the load resistance in the output and input circuits. Then, by applying formula (c), we may calculate the gain required for full output or, if we already know the gain, we may determine whether or not it is adequate.

In general, an amplifier with a rated gain of 130 db will take care of even the most insensitive mike encountered in public address work, operating the amplifier at an output level of approximately 10 watts. This is adequate for most large halls,—in fact, you can do a lot with even 5 watts in an enclosed space. For outdoors, considerably greater power is required, and consequently a greater gain or a more sensitive mike.

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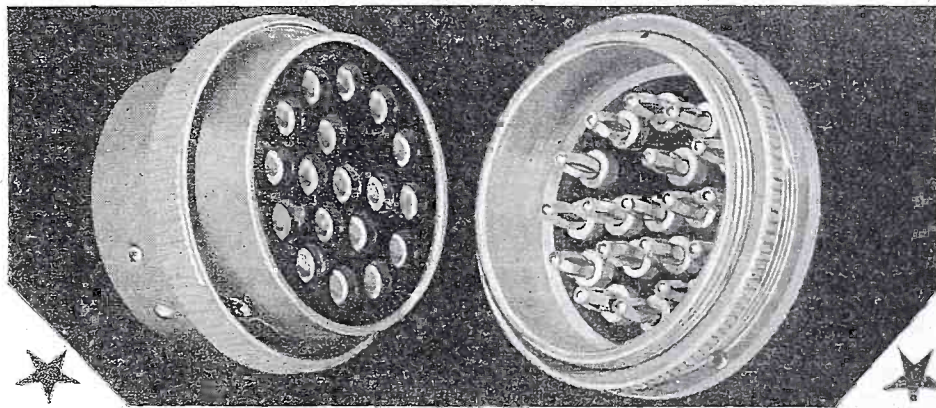
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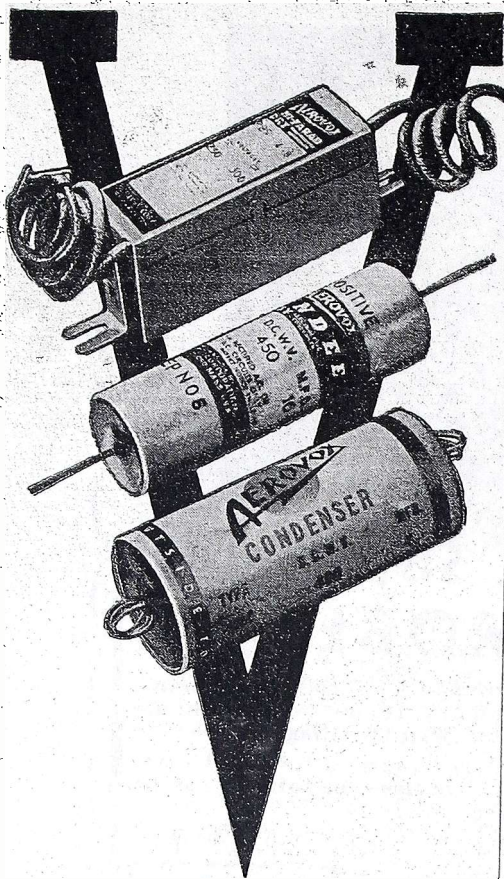
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## Book Review

*MYE TECHNICAL MANUAL*, published by P. R. Mallory & Co., Inc., Indianapolis, Ind. Stiff cloth cover, 8½" x 11" page size, 407 pages including index and tube base wiring diagrams. Price \$2.00.

To properly review this volume, the Fifth Edition of MYE, consisting of 13 excellent Sections, would in itself require a book. Suffice, then, to say that the 1942 MYE is the best yet. By listing the titles of the 13 Sections we outline its broad content: 1, "Loud Speaker Design & Application" — 2, "Superheterodyne First Detectors & Oscillators" — 3, "Half-wave & Voltage Doubler Power Supply Systems" — 4, "Vibrators & Power Supplies" — 5, "Phono-radio Service Data" — 6, "Automatic Tuning" — 7, "Frequency Modulation" — 8, "Fundamentals of Television Engineering" — 9, "DC Dry Electrolytic Capacitors" — 10, "Practical Radio Noise Suppression" — 11, "Vacuum Tube Voltmeters" — 12, "Useful Servicing Information" — 13, "Receiving Tube Characteristics."

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