Radio SERVICE DEALER

Radar Tests, See Page 1.

See Page 1.

$2 PER YEAR

JULY 1943

RADIO-ELECTRONIC MAINTENANCE

The Need for Civilian Radio Service Men is Great...

Will You Help?

Enlistments and drafting of radio service engineers has cut deeply into the ranks of the service men whose job on the home front is to "keep 'em listening."

In some communities, home set servicing is seriously crippled because of lack of service skill. The need for developing new radio service engineering skill is acute. Yet there are thousands of "old timers"—old "radio bugs" if you please—as well as youngsters who have a technical turn of mind, who will be eager to help—if told of the existing need.

Here is a patriotic chance for those of you who remain on the home front. You have the facilities, the know-how, the sources of information to organize radio servicing classes, secure competent instruction and provide the knowledge that will enable set owners to receive help.

You have a big opportunity to help "keep 'em listening" in your community. It is an important service in wartime. And Mallory will be glad to help, with technical information and answers to the questions you may pose.

P. R. MALLORY & CO., Inc., INDIANAPOLIS, INDIANA

P. R. MALLORY & CO. Inc.

MALLORY

Approved Precision Products

Radio SERVICE-DEALER

SOUNDMAN AND JOBBER

Reg. U. S. Pat. Off.

Vol. 4, No. 7 ★ July, 1943

MEMBER AUDIT BUREAU OF CIRCULATIONS

★

Editor & Publisher
SANFORD R. COWAN

Advisory Editor
M. L. MUHLEMAN

Contributing Editors
JOHN H. POTTS
JOHN F. RIDER
"On Leave" Major
U. S. Sig. Corps

Circulation Manager
R. ALAN

★

Executive & Editorial Offices
132 West 43rd St., N. Y., 18, N. Y.

Ad Index

Aerovox Corporation 30
Oil-filled Capacitors
Amperite Company 28
Replacement Ballasts
Anchor Radio Distrib. Service Co. 30
Radio Parts—Accessories
Astatic Corporation, The 29
Dynamic Microphones
Audiograph Sound Equipment 25
Sound Equipment
Brach Mfg. Corp., L. S. 23
Antennas & Radio Parts
Business Press Indust. Scrap Comm. 28
Scrap Drive
Centralab 31
Parts
Clarostat Mfg. Co., Inc. 32
Controls & Resistors
General Industries Co., The 32
Replacement Phono-motors
Hallicrafters 31
Communications Equipment
International Resistance Co. 9
New Wartime Aid
Ken-Rad Tube & Lamp Corp. 24
Radio Tubes
Lafayette Radio Corp. 26
Replacement Parts, Kits & Books
Mallory & Co., Inc., P. R., 2nd Cover
Service Club Plan
Meissner Mfg. Co. 20
Radio Coils and Transformers
Racon Electric Co. 4
Horns, Trumpets & Speakers
Raytheon Production Corp. . . 4th Cover
Tubes in War
RCA Mfg. Co., Inc. .... 3rd Cover
Electron Tubes
Rider, John F. 22
Rider Books & Manuals
Sprague Products Co. 7
"Trading-Post" & Condensers
Standard Transformer Corp. 29
Replacement Transformers
Triplett Elec. Co. 32
Instruments
Universal Microphone Co., Ltd. ... 32
Plugs & Jacks
Utah Radio Products Co. 3
Radio Parts

Contents

Editorial 2
Dealers Are Service Conscious, etc.
Basics Of Sound (Part I) 5
By Sidney Harman & Ira Kamen
Mixer & Converter Circuit Troubles 11
By John H. Potts
Radio Service Engineering (Part I) 16
By Harold Davis
Shop Notes:
Majestic 330, circuit revision 21
General Electric LB-530, shorted charging circuit 21
6A7 Tubes, failure to oscillate 21
Firestone Chassis R-314, poor sensitivity 21
Vibrators, starting failure 21
Welding Old Tube Filaments 21
Truetone D-906; D-911B; D-924; D-925, dials 21
Truetone D-925-B, weak reception.. 26
Atwater-Kent 145, gain data 26
Philco 40-90, gain data 26
12A8 G/GT Substituted for 12SA7 G/GT 26
Eliminating Hum in AC/DC Sets ... 26
Wave Meters 24
War-Time Battery Arrangements . 30
Book Review:
Radio Data Handbook 24

Cover Picture

RADAR

(Photograph by General Electric Co.)

The first pictures of Radar released with sanction of the U. S. Navy Office of Public Relations. Here we see General Electric Company engineers giving Navy Radar equipment production-line tests. In next month's issue we will show other and more intimate views of Radar chassis.

RADIO SERVICE-DEALER, published monthly at 34 N. Crystal Street, East Stroudsburg, Pa., by the Cowan Publishing Corp. Executive and Editorial Offices at 132 W. 43rd Street, New York, 18, N. Y. Subscription rates—United States and Possessions, $2.00 for 1 year, $3.00 for 2 years; elsewhere $3.00 per year. Single copies 25c. Printed in U.S.A. Entered as Second Class Matter October 3, 1941, at the Post Office at East Stroudsburg, Pa., under the Act of March 3, 1879.

DEALERS ARE SERVICE CONSCIOUS

● The June 21st issue of *Advertising Age* reports, "Appliance and radio dealers hang on for postwar boom . . . mortality heavy . . . immediate outlook uncertain." The article, quoting *AA's* findings and survey figures submitted by the magazine *Electrical Merchandising*, continues, " . . . 20% of the country's electrical appliance and radio stores went out of business in 1942 and 24% more will follow suit in 1943. Service work alone can keep most of the surviving dealers alive."

"Last year," says the article, "there were 6,907 radio household appliance stores, 2,409 radio stores and 502 radio-musical instrument stores. In addition, drug, department, furniture, hardware and sporting-goods stores retailed radio-electrical appliances—but . . . many have closed since Pearl Harbor; others continue as doleful shadows." The highlight statement is this: "In 1942 appliance and radio stores drew their income mainly from second-hand goods and from service. Today there are few appliances left, even the second-hand sort. The more the goods run out the more the remaining dealers are forced to concentrate on service. With millions of appliances in use which cannot be replaced . . . there is a large and constant service business."

All facts given above coincide with "*RSD's*" published figures and we are happy that authoritative sources bear us out. "*RSD's* contemporary, a magazine catering to dealers, has contended that the radio-electrical appliance field has been thriving right along. That, to an extent, is why there is a tube and parts shortage. More important, however, is the fact that only a few appliance and radio dealers were able to switch from retailing to servicing after Pearl Harbor and the old-timers in the field of servicing (we call 'em service-dealers) had the big burden placed in their lap.

It is far too late for most retailers to go into servicing. Test equipment and technically trained men are impossible to obtain. The longer the war lasts the more critical becomes the dealers' situation. Eventually, we predict that only service-dealers will survive, and they will have become the nucleus of new dealers that will be here after cessation of hostilities. However, if any retailer can still manage to come into the service field he will be welcomed. Those in the business have more work than they can handle.

14,000 SETS DIE DAILY

● The National Broadcasting Company recently announced that "once the rapidly diminishing surplus of new sets is gone the number of set owners with dead receivers will increase 14,000 daily." NBC should know for its audience is its life blood. At first we were calloused enough to believe that WPB would never permit the public to lose contact with the Executive branch and for that reason alone would make certain that repair parts and tubes would always be available. As hinted in the previous editorial item, perhaps WPB got bad information from a selfish source or perhaps some other factor caused WPB to hold up, until very recently, all types of practical assistance for radio and electrical appliance service-dealers.

As our June issue was rolling on the press we got the flash that an amendment to copper restriction order M-9-c had been issued. Under the new regulation it would be possible for parts manufacturers to produce some replacements that could go into civilian radios. We erroneously captioned our item "Flash—Victory Lines OK'd." As a matter of fact, the transformers and condensers referred to will not be "Victory" lines. The manufacturers can and will label their parts with their proper brand names.

For years radio manufacturers have invested considerable in establishing brand reputations. Experience proved that advertised brands are generally more dependable and cost less. It's a relief to know that private brands will not lose their identity under "Victory" or ". . . —" stickers. And incidentally, the newly adopted standards for wartime lines of condensers and transformers were published in full in the February 1943 issue of *Radio Service-Dealer.*

BLACK MARKET THREAT

● OWI announced that farmers complain about being forced to pay exhorbitant prices for batteries because of the scarcity. Says OWI, "Complaints reaching OPA that radio battery packs which normally retailed for $5 to $7 have lately been selling at $10 to $14 each." This situation is rank. Have dealers forgotten that radio component and accessory prices were frozen at March 1942 levels? Take heed! The sale of any commodity in violation of fixed ceiling prices is punishable by stiff fines and jail sentence. Only a limited number of batteries have reached jobbers. Unless those that do reach jobbers are turned over cleanly, it is possible that WPB may shut down on future production schedules entirely. We can't afford to have this happen. Kill the black market by refusing to indulge in it.

POTENTIALITIES OF SOUND

● Before Pearl Harbor the radio industry had an infant called Sound. It was growing nicely. Then the military services, shipyards and countless other war industries took all sound equipment output on high priorities. Sound speeds up production, adds to plant efficiency—pays for itself in a short time. We qualify that by saying that the *proper type of sound installation* affords advantages, all others are worse than none at all.

A lot of money can be made in the renting and maintenance of sound now, and after the war, in the selling of same. For that reason "RSD" launches the most comprehensive series of articles on the general subject of sound. All phases are to be covered from all angles. Sound is an industrial electronic application just as is the photocell-operated counter and sorter. Its ramifications are countless. Mathematics and acoustics play a big part in sound; a knowledge of amplifier circuits is quite incidental. Look ahead!

TESTED ON AN ATOLL

ON a tiny strip of coral . . . an observation post pierces the dawn with cryptic messages that may spell the difference between victory and defeat. Duty on this speck on your map calls for iron men and dependable equipment.

Under the toughest of conditions . . . under the roughest of handling . . . far from sources of replacement . . . parts must work—for men's lives hang in the balance. Utah Parts are passing this final test on tiny atolls, in steaming jungles, on burning sands in all parts of the world—from pole to pole.

A shooting war is also a talking war. The weapons of communications must have the same dependability and non-failing action as weapons of destruction. These qualities are built into Utah Parts at the factory where soldiers of production are working 100% for Victory. In Utah laboratories, engineers and technicians are working far into the night developing new answers to communication problems—making improvements on devices now in action.

But "tomorrow" all this activity, all this research, all this experience learned in the hard school of war, will be devoted to the pursuits of peace. Thanks to the things now going on at Utah—there will be greater convenience and enjoyment in American homes . . . greater efficiency in the nation's factories. UTAH RADIO PRODUCTS COMPANY, 836 Orleans Street, Chicago, Ill. Canadian Office: 560 King Street West, Toronto. In Argentine: UCOA Radio Products Co., SRL, Buenos Aires. Cable Address: UTARADIO, Chicago.

PARTS FOR RADIO, ELECTRICAL AND ELECTRONIC DEVICES, INCLUDING SPEAKERS, TRANSFORMERS, VIBRATORS, VITREOUS ENAMELED RESISTORS, WIREWOUND CONTROLS, PLUGS, JACKS, SWITCHES, ELECTRIC MOTORS

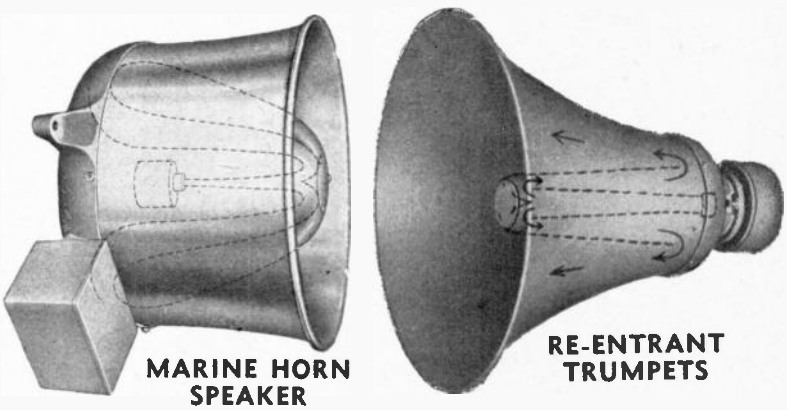
utah

Nelson Did Not Have RACONS

Lord Nelson's commands were given by blinker light, signal flag or megaphone. Such undependable means of communications often caused great loss of life — even the loss of battles. But times change!

Now-a-days our fighting men at sea — on all types of vessels — are afforded great protection by many types of RACON loudspeakers and driving units.

On land, too, RACONS do their bit. They are preferred by sound experts who know RACONS deliver greater output per watt of energy input — they are most efficient and dependable. Competitively priced, RACONS may be obtained for shipyard, industrial war plant and similar important sound installations. There is a RACON for every conceivable application. Get further particulars today.



Here are but two of the many RACON Speakers. The Marine Horn Speaker is of the re-entrant type, for marine and general p-a applications. Available in several sizes, from 5 to 50 watts, they may be used as loudspeaker or as microphone. Approved by the U. S. Coast Guard, (formerly the Bur. of Marine Inspection, Dep't of Commerce.) RACON Re-entrant Trumpets occupy small space but afford a long horn that carries highly concentrated sound efficiently over long distances. Several sizes available.

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

RACON

BASICS OF SOUND

by

Sidney Harman† & Ira Kamen‡

This is the introduction to a series of articles analyzing the practical design of audio equipment. It is aimed at the sound or radio man, desirous of obtaining a basic understanding of design and the ability to actually "put the correct equipment together so that it does the job it is supposed to do". The service-dealer will find this information very practical. It will greatly extend the scope of his work, and equip him to tackle many problems which once seemed too complex.

Successive articles will deal with every step in the design of audio equipment, exhaustively covering every factor involved.—ED.

NOT tomorrow but *today* is the Field of Sound.

The great wealth of developmental work which the war has created has resulted in tremendous improvements in old equipment, and in very many new types of equipment. If the equipment itself is new however, the principles of sound and the fundamentals of design which created it are not.

It is the purpose of this article to discuss the phenomenon of sound as the introduction to analyses of the equipments which amplify and transmit it. The word "sound" bears a double duty. No distinction is normally made between that phenomenon which exists in time and space, which can be examined, measured and controlled, and that phenomenon which is involved with the excitation of a brain center to produce the subjective sensation of hearing. References in this and subsequent articles to the word "sound" are strictly limited to the first phenomenon (the movement of air molecules and the empirical conclusions about hearing, drawn from experimentation). In other words, we will deal with sound from the time it is originated until it reaches the hearing mechanism.

Components of Sound

The visual form of sound is that of a wave. Its three major components are loudness, frequency and quality. Each of these components is sustained by a physical property of the sound wave.

Loudness is the amplitude of vibration. Frequency is the number of vibrations that take place in a second, and quality is the form which those vibrations assume. A musical note, for example, has a uniform curve whereas noise has an irregular curve which produces a disagreeable subjective sensation.

From a subjective point of view, sound is as loud as you hear it and the same objective sound may appear to be of different intensity to one person than to another. Objectively, *sound intensity varies inversely as the square of the distance from the source.*

Measurement

The auditory response to a sound of constant frequency is approximately logarithmic. The intensity of any sound which can be detected varies greatly with frequency. The greatest sensitivity is usually around 1,000 vibrations or cycles per second.

The American Standards Association has proposed the use of 1×10^{-10} microwatts per square centimeter (or 1×10^{-16} watts per sq. cm.) as the unit of sound intensity. At 1000 cycles per second, this corresponds to the threshold of audibility (the minimum intensity of sound which can be heard). It is recognized, of course, that this is a working reference level—that the threshold of audibility for many persons is actually well above 1×10^{-10}, and it should further be noted that the threshold is stated at 1000 cycles. Between 3000 and 4000 cycles it is 2×10^{-11} microwatts per sq. cm.

Intensity of sound is a component which can be easily measured. Intensity is actually a function of velocity, of pressure, and of density. The relationship of these three factors is:

$$W = \frac{P^2}{DV}$$

where
W = microwatts per sq. cm.
P = pressure in dynes per sq. cm.
D = density of the medium in grams per cubic cm.
V = velocity of sound in the medium.

The velocity of sound in dry air at 0° Centigrade is approximately 1,080 feet per second, and it increases at the rate of two feet per second for each degree of temperature rise. Thus if the temperature of a large auditorium is 20°C. it can be seen that sound in that auditorium has a velocity of 1,120 feet per second. The sound ranging altimeters employed in aircraft today operate on the principle that the distance between the plane and earth can be determined in terms of the known velocity of sound and the time it takes for a signal to travel to earth and back to the plane.

Sound waves are composed of alternate compressions and rarefactions of the air molecules which make up the atmosphere. A single wave consists of one compression and one rarefaction. The exact length of this wave in feet is called the *wavelength* of the sound wave. The wavelength is a function of velocity and frequency in this relationship:

$$\text{Wavelength in feet} = \frac{\text{velocity}}{\text{frequency}}$$

† Engineer, David Bogen Co., N. Y.
‡ Member, Institute of Radio Engineers

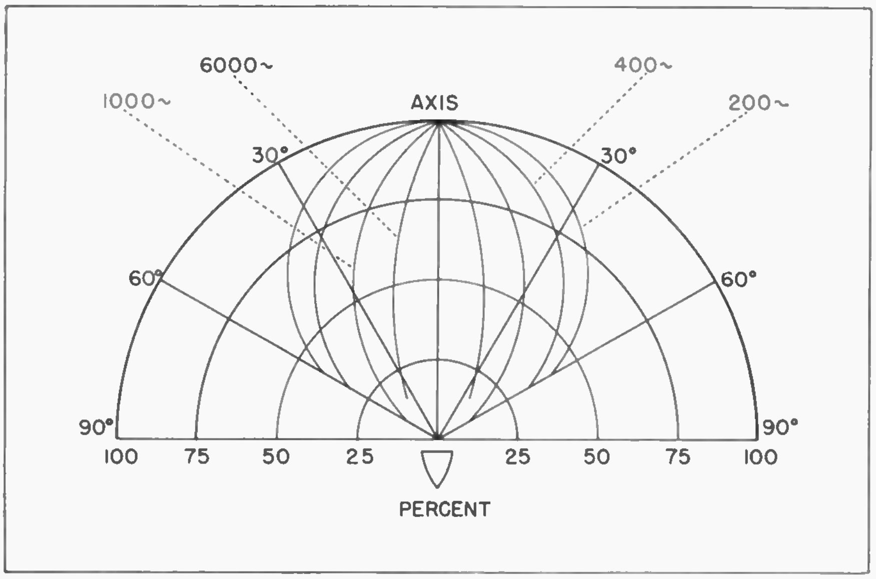


Fig. 1. A polar diagram such as this helps determine speaker response characteristics.

Thus, the length of the sound wave created by a speaker, vibrating in dry air at 0°C. at a frequency of 1000 cycles per second is: $W = \frac{1,080}{1000} = 1.08$ feet. It can be seen from the formula that the higher the frequency the shorter the wave length. A derivative of the formula $W = \frac{P^2}{DV}$ permits the translation of pressure measurements in dynes per sq. cm. into the more commonly employed unit of measure, *decibels*

$$Db = 20 \log_{10} \frac{P}{.0002}$$

P is any known sound pressure in dynes per sq. cm., and .0002 is the reference level in dynes per sq. cm. It is the equivalent of 2×10^{-4} dynes per sq. cm. and is equivalent to 1×10^{-10} microwatts or to 0 db. It can be seen that if P in the above formula were actually .0002 dynes per sq. cm. the formula would read $db. = 20 \log_{10} \frac{.0002}{.0002}$ or $20 \log_{10} \times 1$. The log of 1 is 0, and 20 times the log of 1 is also zero. Therefore the relationship between .0002 dynes per sq. cm. and .0002 dynes sq. cm. is 0 db (the threshold of hearing).

Referring again to the formula $W = \frac{P^2}{DV}$ and transposing, the formula $P^2 = WDV$ is achieved. It can be seen that as density and/or velocity increase, W (in microwatts) must be decreased to maintain the same pressure in dynes per sq. cm. As density and/or velocity decrease, W must be increased to maintain the same pressure. Thus at high altitudes, where density is low and velocity (function of temperature) is decreased, greater power is required to achieve an equivalent pressure.

Intensity limitations

There is, of course, a minimum sound intensity to which the human ear will respond, and below which we say, one does not hear. There is too, a maximum sound intensity to which the ear can respond without the sensation of pain.

Fortunately the ear is of such construction that it can respond to a truly tremendous range of sound intensity. The classic example of the symphony orchestra will clarify this point. A complete orchestra, playing at its maximum creates one million times the sound power that it does when playing a soft passage. The human ear, however, does not hear the maximum one million times as loud as the minimum. Actually it hears it only sixty times as loud.

Differences in sound intensity when discussed as to their effect on the ear must be analyzed as being proportional to the logarithm of the difference in sound intensity.

To translate sound intensity in microwatts into decibels (the basic unit of measurement of sound), the formula $DB = 10 \log_{10} \frac{W}{1 \times 10^{-10}}$ is used. W is any sound power measurement in microwatts, and 1×10^{-10} is, of course, the American Standards Association reference level in microwatts.

Frequency, the second component of sound, denotes the number of vibrations that take place in one second. The lowest frequency which can be detected by the ear as a sustained note is 16 cycles. Below this frequency only pulses can be followed. The upper limit of audibility varies considerably with different people. Generally, it is about 18,000 cycles. Some people can distinguish pure signals no higher than 15,000 cycles per second, and others can detect signals as high as 22,000 cycles per second.

The relationship between frequency, velocity and distance explains a most interesting phenomenon, the Doppler Effect. The pitch of a sound, as heard, is dependent upon the number of waves that reach the ear in any one sound. If the ear is approaching the source of sound, the pitch will rise, and inversely as the ear recedes from the source of sound, the pitch will fall. Thus, a rise in pitch (shrillness) is experienced as a locomotive whistle approaches, reaching its maximum at the point of nearest proximity to the ear, and a lowering in pitch is noted as the locomotive moves away. The specific pitch or frequency is of course dependent (among other factors) upon the velocity of sound which varies with temperatures as noted above.

Quality or Harmonic Value

Quality, the third component, permits the distinction between different notes of the same frequency and intensity. Various factors modify the harmonics of the fundamental frequency which may be produced, and these harmonics enable us to recognize voices. One speaks therefore, of the difference in quality of men's voices.

When two notes of slightly different frequency are sounded together, a periodic vibration in intensity is heard, and the intensity of the audible note will swell and diminish at

The SPRAGUE TRADING POST

EXCHANGE — BUY — SELL

Your own ad run FREE!

The "Trading Post" is Sprague's way of helping radio servicemen obtain the parts and equipment they need, or dispose of the things they do not need during this period of wartime shortages. Send in your own ad today—to appear free of charge in this or one of the several other leading radio magazines on our list. Keep it short—WRITE CLEARLY—and confine it to radio items. "Emergency" ads will receive first attention. Address it to:

SPRAGUE PRODUCTS CO., Dept. RSD37
North Adams, Mass.

MARINE CORPS OUTFIT NEEDS—Good used communications receiver similar to an SX28 or SX32, for use in recreation hut. Government check for immediate action. A. E. Kirkland, Marine Gunner, USMC, Corps Signal Battalion, 1st M.A.C., c/o Fleet Post Office, San Francisco, Calif.

INSTRUMENTS WANTED FOR CASH—Jackson Model 640, Triplett 1232-A, Weston 776, Precision E-200, Radio City 702 or 703 or any good make oscillator urgently needed; tube tester Supreme 589, Triplett 1213 or 1612, Jackson 634, Radio City 309 (P or C) or 310 (P or C) or any other good make tester also needed; also latest edition of Sprayberry's Master Servicing Course. All must be in perfect condition. Send details and best cash price. All replies answered. Gentil G. Da Rosa, Lincoln Highway, Box 114, Plainfield, Illinois.

WANTED— An "outside-in" record-er lead screw, RCA type, MI-4821, for RCA recording attachment MI-4815-4820. Radio Station WMRN, N. Main St., Marion, Ohio.

URGENTLY NEEDED— Motor-generator (separate units) or rotary converter; input 110 V. AC.—output 32 V. DC. 75/100/125 watts; must be in working order. State make and cash price. Joe's Radio Service, Berrysburg, Penna.

FOR SALE— Rider's Manuals, vols. 1 to 7—$40. Pernal's Radio Service, 1311—10th Avenue, Beaver Falls, Pa.

WANTED— Radio tubes types 84, 75, 15, 45, 41, and 31. Will pay 30c apiece. M. O. Smith, Box 265, Pagosa Springs, Colo.

WANTED— Pocket size volt-ohm M.A. meter or Triplett model 321 0-1 M.A. meter. Please state make, condition and price in first letter. All letters answered. Wendell Derry, 16 Park St., Hyde Park, Mass.

WANTED— Volt-ohmmeter, signal generator, V.T. voltmeter and Rider chanalyst or oscilloscope; any make or model—reasonable. Send list of what you have, and price. Ray L. Brown, 159½ Second Avenue, South Charleston, W. Va.

TUBES FOR SALE— Types 6X5, 5Y3, 6A8, 6L6, 6F7, 6U7, 6F6, 6K6, 6Q7, 6V6, 12SA7, 12J5GT, 12SK7, 32L7, 25N6, 25L6, 30, 56, 58 (total quantity is 25 tubes—priced 25% under list). Also, for sale, Hammarlund variable condensers types MDC, SM-100, and MC-20-S; Thordarson Transf.; one audio coupler $1.00; one microphone coupler $1.00; bound vol. Zenith service manual 1928 to 1938—75c. N. J. Cooper, 4617 No. Damen Ave., Chicago, Ill.

WANTED—Jackson portable tube checker, model 634 or 636. Give complete description and price. Baker Radio Sales & Service, 510 W. Sprague Avenue, Spokane, Wash.

FOR SALE— RCA type TMV-122B cathode-ray oscilloscope. 3" screen, A-1 condition. Best cash offer takes it. George Dohm, W3G22, 438 West King St., York, Pa.

WANTED—Vedolyzer, audolyzer or Hickok traceometer. Cash for one in A-1 condition. Give complete details and price. George Griffin, 7513 St. Clair Ave., Cleveland, Ohio.

FOR SALE— 2" oscillograph, in perfect shape. The Radio Man, 1724 Central Ave., Middletown, Ohio.

WANTED AT ONCE—A good communication receiver, a Hallicrafter S-20R, S-29, Skybuddy or Echophone EC-1. Must be in excellent condition. Give full details and price. Pfc. G. F. Preston, H&S Co. Inf. Bn. TC, U.S.M.C., Camp Elliott, Calif.

URGENTLY WANTED—A Weston model 698 selective set servicer; also a signal generator with a frequency range to 25 MC. Give full description and price. Blaney's Radio Shop, 202 Troy St., Canton, Pa.

WANTED— Test sets, all kinds; radio tubes; also 16 M.M. sound projector. Send list and prices to Robleski Electric, Hastings, Mich.

WILL TRADE—Want pistols, rifles, ammunition, all types; have photographic equipment and radio tubes. Carl Morris, Instructor, U. S. Army Sig. Corps, Johnson Radio School, Lexington, Ky.

FOR SALE OR TRADE—Hickok traceometer, model 155; would take good volt-ohm-milliameter of reliable make in on trade. Seifert Motor & Impl. Co., Utica, Minnesota.

WANTED— 1" or 2" oscilloscope; also short wave receiver. Send description and price. Harry H. Gingrich, 4613 Derry St., Harrisburg, Pa.

FOR SALE— Complete eight-unit, 6-station, 56-tube Carrier call inter-building communicator; private communication between any two stations without interstation wiring. Write for details. Cash preferred or 5" Dumont 'scope. Oscar W. Tyree, 2101 Fifteenth St., Troy, N. Y.

WANTED—Ohm - volt - milliameter; preferably with AC and DC scales, with or without analyzer provisions. T. M. Duffield Co., 1617 So. 17th St., Lincoln, Nebr.

FOR QUICK SALE—Korelle reflex series 1, 2.9 Schneider, carrying case, Dallmeyer 6" telephoto, lens shade; all guaranteed perfect; going foreign service; close out for $150. Carl Morris, P. O. Box 1094, Lexington, Ky.

WANTED IMMEDIATELY—0.1 M.A. meter or a 0-50 microam. meter of at least 2% accuracy. Submit prices and specifications. Billy Griffith, 518 N. Vine St., Monroe City, Mo.

RECORDER WANTED— Professional or semi-professional portable model. Would accept quality radio-recorder combination. What have you? Wm. V. Drinkard, General Delivery, Manette Sta., Bremerton, Wash.

COMMUNICATION RECEIVER WANTED— Such as HQ-120-X in good condition with speaker. Give full details and price. Sgt. Alex O'Kulich, Co. A, 2nd Arm'd Sig. Bn., East Garrison, Fort Ord, Cal.

WANT CONDENSER ANALYZER—Solar model. Must be in operating condition. Give details and price. All letters answered. Beacon Radio Service, 532 E. Blancke St., Linden, N. J.

WANTED— RCA VoltOhmyst, Radio City Products Electronic multitester No. 662 or similar equipment. Sam Posen, 1432 S. St. Louis Ave., Chicago, Ill.

WANTED— Any standard make A.C.-D.C. voltohmmeter, also Solar condenser analyzer. Must be in good condition. Give full details and cash price. William E. Caron, 133 Boren Ave. No., Seattle, Wash.

WANTED FOR CASH— Voltohmmeter or test tube tester. State make, price, and condition. David S. Miya, Blk. 29-11-2, Manzanar, Cal.

FOR SALE— One GE #AZ-133A phonograph motor complete with turntable; one Motorola 8-tube push button auto radio #969; one Jewell pattern #54 0-3 DC ammeter; one Jewell pattern #54 0-7 and 0-140 combination DC voltmeter. Write for prices and details. Louis E. Farrell, 316 Pine St., Burlington, Vt.

WANTED FOR CASH— Aerovox model 95 L-C checker, also a signal generator. State price and condition. Herbert Wenzlaff, Toluca, Ill.

TUBES TO TRADE— Have 35L6GT and 12SQ7GT and other scarce tubes to trade for your 35Z5GT or 12SA7GT tubes, or will pay cash for the latter. Write. Granger Radio Service, 62 Spring St., Rochester, N. Y.

RCA VOLTOHMYST WANTED — Will pay original list price for Jr. model unit in good condition. Roy McAfee, 3613 Belair Road, Baltimore, Md.

THEIR LITTLE ADS BROUGHT BIG RESULTS!

A Few Typical Comments from Among Hundreds We Have Received

"I have had excellent requests from the Trading Post ad you ran for me—seven requests in three days, and they're still coming." W. T. N., Illinois.

"Thank you for my advertisement in the Sprague Trading Post. Received 4 replies to my request for an oscilloscope." O. B., Brooklyn.

"Thanks for running my ad—I sold two meters right off the bat." A. R. D., New York.

"I received an answer to my ad two days after the magazine came out, and a week later I had the oscillator I wanted." F. L., Conn.

"Received several replies and purchased the condenser tester I needed. I gave the other replies to other servicemen who also needed such equipment." J. A. S., New York.

"Please accept my sincere thanks. I was literally swamped with replies to my Sprague Trading Post ad and had no difficulty in disposing of the apparatus at a good price. This is a splendid service you are rendering—and just one more reason why we servicemen will continue to buy Sprague Condensers." R. B., New York.

SEND IN YOUR AD TODAY!

Ask for Sprague Atoms (midget drys) by name! Use them universally on EVERY electrolytic condenser replacement job!

SPRAGUE PRODUCTS CO.
North Adams, Mass.

SPRAGUE CONDENSERS AND KOOLOHM RESISTORS

Obviously, Sprague cannot assume responsibility for or guarantee goods, services, etc., which might be sold or exchanged through above advertisements.

regular intervals. Actually at regular intervals, the two notes are in such relation that the compression of one reinforces the compression of the other, producing a note of higher intensity, called a "beat." At another instant the compression of one note will combine with the rarefaction of the other, effectively cancelling each other, and producing weak or practically inaudible tones. The number of "beats," heard per second is the actual difference in frequency between the two struck notes.

For physiological reasons within the hearing mechanism a low tone (low frequency) of high intensity will blot out the sensation of a high frequency tone of low intensity. A tone of higher frequency, however, can blot out a tone of lower frequency if the frequencies are close together. Ah igh frequency note cannot blot out or mask a note of low frequency (even if the high frequency note is of high intensity) if the two are well removed. These "making effects" are of extreme importance in the distribution of sound in industrial locations.

Reflection Distortion

No matter how well articulated the original sound and how precise the amplifying and distribution equipment may be, the result in terms of what actually reaches the ear may be thoroughly unsatisfactory if the area in which the amplified sound is dispersed, is itself inimical to proper distribution. Everyone has, at some time, suffered the miserable experience of sitting in a hall or theatre where it was practically impossible to hear what was being said on the stage. Children enjoy few things more than the awesome result of bellowing in an empty gymnasium or hallway. Distorted reflections of their own voices bombard them from every angle, but there is little to be enjoyed in this phenomenon when the result desired is to hear a speaker or listen to music clearly, audibly and naturally. Certainly neither of these conditions is desirable and obviously, the acoustic treatment of the area in which sound is dispersed, is as vital a consideration as the design of the equipment which disperses it.

The most frequent acoustical defect manifests itself in unwanted reflections of sound power which produce echoes, so immediate to the direct sound that the result is a confusing pattern of the single direct sound. Often too, these reflections "beat" with the direct waves, effectively cancelling them and producing dead spots.

Reverberation Distortion

Reverberation is another undesirable acoustical effect, often confused with reflection, but actually very different in nature and result. A so-called "live room" continually reverberates the sound waves back and forth until the whole room is literally filled with "sounds," which gradually diminish or decay. Rooms with bare plaster or hard wood walls are naturally subject to this condition and the lay solution is often to open windows. This permits greater absorption of the sound energy, because the atmosphere beyond the open window offers no reverberating surface to the movement of the sound waves. If some solution is not made, it may take as long as two to four seconds for the reverberations to decay. When this condition exists (too long a reverberation time) two or three notes will actually be sounding in the listener's ears while the fourth is being played. (By definition, the reverberation time is the time required for the mean energy density in the room to drop 60 db.)

Dr. Sabine of Harvard University claims that a room should have a reverberation time of almost one second to be suitable for music. If the reverberation time is too short, the music loses its dynamic quality and is not thrilling. Such a room is considered "dead."

Draping the room, filling it with people, cushioning the chairs, employing sound absorbent materials for wall construction; all are methods used to reduce reverberation time, through absorption of the sound energy. Different materials have different absorption values or absorption coefficients, and the approximate reverberation time can be calculated by the formula: $T = 0.00161 \frac{V}{a}$ — where V is room volume in cubic centimeters and a is the total room absorption. Obviously where T is too large, it can only be reduced by increasing the value of a.

Recent work in the control of reverberation or "confined resonance" has eliminated the use of padding, and substituted curved walls and parabolic panels for the conventional flat surfaced, draped walls. Sound energy striking such surface is diffused through the area of the room in ideal decay relationships. Instead of absorbing the energy, its diffusion is controlled to achieve maximum realism of sound with a minimum of echo.

It is the function of the audio amplification system to increase the signal strength supplied by the sound source to such an extent that the resultant sound power will be sufficient to cover a desired area.

In supplying the requisite power it must faithfully reproduce the quality of the original signal. The design of the component parts of the amplifying system, and the proper matching and assembly of these component parts will be analyzed in subsequent articles.

"Sergeant, at the sound of the explosion I'll be about 50 yards due north. I hope!"

Remember the "Here's How" contest, recently sponsored by I R C in leading Service Papers throughout America? . . . Hundreds of Service Men sent in their suggestions on how to replace volume controls and get radio sets working satisfactorily when the controls which normally would be used were not available.

The contest judges had a tough job picking the winners and the runners-up. Piles of letters had to be read—diagrams checked. But now it's all in shape and we've put the *ten top ideas* in a booklet to help everyone in the industry faced with a volume control problem. As an added feature we've included the latest data on ½, 1 and 2-Watt Resistors (both Metallized and Wire-Wound), together with substitution information on 10-Watt Wire-Wound Resistors, now so difficult to obtain.

These booklets are so timely and so useful to Service Men that we don't think our supply will last very long. May we suggest that you write today *for your copy? No charge, of course.*

PREFERRED FOR PERFORMANCE
IRC
REG. U.S. PAT. OFF.
FIXED & VARIABLE RESISTORS

CLIP AND MAIL THIS COUPON TODAY

INTERNATIONAL RESISTANCE COMPANY
401 N. Broad Street, Philadelphia 8, Pa.

Gentlemen:

Please send me a copy of your new "HERE'S HOW" booklet.

(Please Print Name and Address)

NAME__________

COMPANY__________

ADDRESS__________

CITY__________ STATE__________

My Regular Distributor is RSD

TO HIT 'EM H-A-R-D-E-R

THE year 1943 promises to be the grimmest, hardest year this country has ever faced. Every effort, and every dollar of national income not absolutely needed for existence, should go into war work and War Bonds.

In the Pay Roll Savings Plan, America finds a potent weapon for the winning of the war—and one of the soundest guarantees of the preservation of the American way of life!

Today about 30,000,000 wage earners, in 175,000 plants, are buying War Bonds at the rate of nearly half a billion dollars a month. *Great as this sum is, it is not enough!* For the more dollars made available now, the fewer the lives laid down on the bloody roads to Berlin and Tokio!

You've undoubtedly got a Pay Roll Savings Plan in your own plant. But how long is it since you last checked up on its progress? *If it now shows only about 10% of the gross payroll going into War Bonds, it needs jacking up!*

This is a *continuing* effort—and it needs *continual* attention and *continual* stimulation to get fullest results.

You can well afford to give this matter your close personal attention! The actual case histories of thousands of plants prove that the successful working out of a Pay Roll Savings Plan gives labor and management a common interest that almost inevitably results in better mutual understanding and better labor relations.

Minor misunderstandings and wage disputes become fewer. Production usually increases, and company spirit soars. And it goes without saying that workers with substantial savings are usually far more satisfied and more dependable.

And one thing more, these War Bonds are not only going to help win the war, they are also going to do much to close the dangerous inflationary gap, and help prevent post-war depression. The time and effort *you* now put in in selling War Bonds and teaching your workers to save, rather than to spend, will be richly repaid many times over—now and when the war is won.

You've done your bit Now do your best!

MIXER & CONVERTER CIRCUIT TROUBLES

by John H. Potts

MANY of the most baffling troubles encountered in superheterodyne receivers originate in mixer and converter circuits. Some of these faults are due to basic limitations in the design of the converter or mixer tubes; others to the difficulties experienced in eliminating unwanted frequencies which are unavoidable by-products of such circuits. The phenomenon of "superheterodyne hiss," formerly one of the most prevalent—and least understood—types of trouble, finds its origin in converter action. A certain form of "motor-boating," apparent on shortwave reception, is due to faults in converter design or in the circuits associated with the converter tube. To which may be added a choice assortment of birdies, which have settled upon converter and mixer circuits as ideal nesting places.

It is not difficult to see why such troubles can arise, once we analyze the circuits. The tough part is to figure out ways and means of overcoming such faults. In some cases the changes required are slight; in others we may have to redesign the circuit from stem to stern, changing the tube, oscillator coil, biasing and what not. Usually such drastic treatment will be required only on sets which are several years old, and in some cases just won't be worth the trouble. But in any event it's a good thing to know just what needs to be done, and there are alternative methods which are simpler, if not entirely effective, in minimizing such troubles.

How Converters Function

The block diagram, *Fig. 1,* illustrates in its simplest form the principle of superheterodyne mixer action. And this illustration will of course serve to show also how converters function, because the converter is simply a combination oscillator-mixer in a single tube envelope. The broadcast signal, *F1*, is shown as a 600-kc signal being fed to the mixer input, while the local oscillator in the receiver is tuned to a frequency of 1065 kc, and is likewise fed to the mixer. In the mixer these two signal frequencies combine to produce, among others, a frequency equal to the difference between the signal and oscillator frequencies, or *F2-F1*, which is equivalent to 1065-600, or 465 kc. Since this is the frequency to which the i-f amplifier is tuned, this 465-kc signal is amplified and passed on to the detector circuit.

If this 465-kc beat frequency were the only one which was produced when the set was tuned to a given signal, all would be well. However, a moment's thought shows that when the set oscillator is tuned to 1065 kc, as illustrated, a 465-kc beat will result not only when the incoming signal is 600 kc, but also when a signal equal to 1065 kc plus 465 kc is present in the mixer circuit. This means that a 1530-kc signal will likewise beat with the 1065-kc oscillator signal to produce a beat in the output which is also 465 kc and which will pass through the i-f amplifier along with the desired 600-kc broadcast signal, to which the r-f portion of the set is tuned.

This undesired difference frequency which produces in the mixer output an interfering signal equal in frequency to that of the desired signal bears a special name—*image frequency*. The image frequency always differs from the desired signal frequency by an amount equal to twice the intermediate frequency. Thus, in this instance, the desired signal frequency is 600 kc and twice the intermediate frequency equals 2 × 465 or 930 kc, which, added to 600 kc, gives us an image frequency of 1530 kc. In most receivers, the local oscillator frequency is higher than the incoming signal frequency, therefore the image frequency is likewise higher in frequency than the oscillator. However, in some sets, on short-wave bands the oscillator frequency is lower than that of the incoming signal. In such cases, the image frequency will likewise be lower than that of the incoming signal, but always by an amount equal to twice the intermediate frequency.

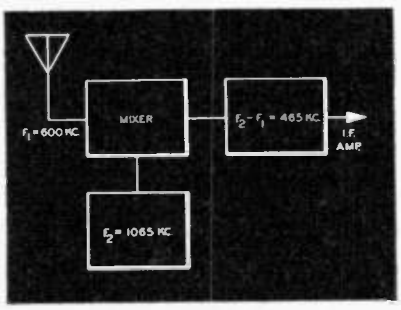


Fig. 1. The fundamental principle of superhet mixer action is represented in this block diagram.

Image Frequency

Image frequency interference is not of much consequence on the standard broadcast band, because even a single tuned input stage is generally sufficient to reduce to a negligible value the amplitude of the image frequency, particularly when the intermediate frequency is relatively high (450 kc or thereabouts). In some of the older receivers employing 90 to 175 kc intermediate frequencies, this trouble was encountered even on the standard broadcast band, because then the difference between the image frequency and the desired signal frequency becomes relatively small.

Even when intermediate frequencies of the order of 450 kc are employed, trouble with image frequency interference is often experienced on short-wave bands. This is because the intermediate frequency is then

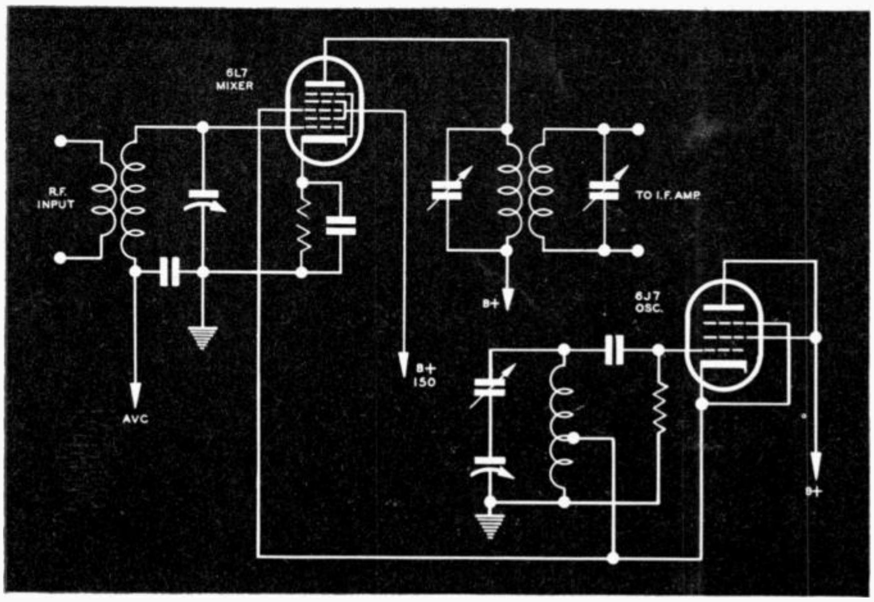


Fig. 2. This particularly efficient mixer circuit is used in a commercial short-wave receiver. The 6J7 oscillator voltage is fed from the cathode tap to the injector grid of the 6L7.

but a relatively small percentage of the incoming signal frequency and a single tuned circuit finds difficulty in discriminating between signals which differ in frequency by only a small percentage. That is one reason why it is particularly desirable to have one or more tuned r-f stages ahead of the mixer, for best short-wave reception. And when working at frequencies above 20 mc, it is generally necessary to use much higher intermediate frequencies, in addition to the r-f amplification ahead of the mixer. This, as we all know, is what is done in f-m receivers, where i-f's of the order of 3 to 11 mc are employed.

Image frequency interference is the most common and best known of mixer or converter troubles. Also common, but not always understood as a converter trouble is the phenomenon of motor-boating or flutter, which occurs on short-wave reception. This is not to be confused with the common garden-variety of motor-boating due to poor power supply filtration and other causes of undesired coupling between stages. The type of motor-boating we refer to occurs on strong signals on short-wave bands and is due to a change in frequency of the oscillator section of the converter resulting from a change in bias caused by the avc action created by the incoming signal. This change in avc voltage, which is applied to the converter control grid, reacts on the oscillator portion of the converter tube and detunes it. The detuning automatically reduces the converter output signal, which in turn reduces the signal arriving at the avc diode and hence the avc voltage. As soon as the avc voltage is reduced, the oscillator voltage again changes, bringing the oscillator back into alignment and the signal and avc voltage levels are again increased. This cycle of oscillator detuning and returning to alignment takes place at a rate determined by a portion of the time taken to discharge and charge the condensers in the avc filter network, usually about 1/10th to 1/20th second. Thus the signal level increases and decreases at the same rate, and results in what sounds like motor-boating.

Regulating Oscillator Voltage

The trouble just described is most prevalent in early receivers employing a 6A7 or 6A8 converter. A measure of correction was introduced into communication receivers by using a voltage regulator tube to control the supply voltage to the oscillator section of the pentagrid converter. While this does the trick, it does add another tube and thus increases the complexity of the circuit. Newer converter tubes, such as the 6SA7, are relatively free from this trouble. The trouble may be reduced, in receivers having an r-f stage, by applying only a portion of the avc voltage to the converter control grid, the maximum control voltage being applied to the r-f and i-f grids. This may of course be done also when the set has no r-f stage, but then the converter input is likely to become overloaded on strong local signals.

Superheterodyne "hiss" is usually noise developed in the converter or mixer tube. It is unfortunately true that the converter tube is inherently a noise producer in that the thermal agitation and other noise produced in it amounts to about four times that produced in a diode or triode and twice that of a pentode. The conventional method of overcoming this trouble is to use r-f amplification ahead of the converter. This increases the signal-to-noise ratio to the extent that the converter noise becomes negligible.

Phase Shift

In addition to noise troubles, at high frequencies — above 30 mc — some converter and mixer tubes have a tendency to draw control grid current due to a phase shift which takes place as a result of electron transit time and capacitative effects. In such instances an appreciable portion of the oscillator voltage may appear at the control grid, and the resulting grid current loads the input circuit and reduces the gain. More serious, when avc is applied to the grid, the bias on all tubes under avc control is increased, with a consequent large reduction in the overall sensitivity of the receiver. When complaints of weak reception on very short wave bands are received, it is well to look into this as a possible explanation. One difficulty in testing for this trouble is due to the fact that an electronic voltmeter (an instrument which cannot be purchased now without priority) is required to measure avc voltages in such high resistance circuits. However, it is possible to obtain an indirect indication of the avc bias by noting the change in plate current which takes place between a reading taken with the avc bus grounded and one with it operating normally. To determine whether the change in bias is due to grid current in the mixer circuit, note the avc bias—or the plate current of a controlled tube—with and

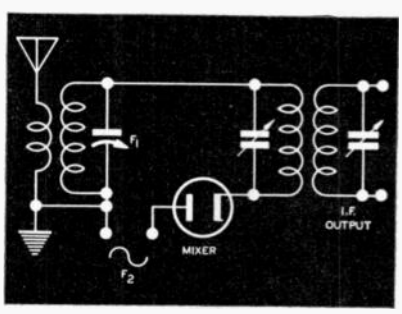


Fig. 3. This circuit illustrates the use of a diode employed as a mixer.

without oscillator voltage being fed to the mixer; or, in the case of a pentagrid converter, note the effect on the bias resulting from grounding the oscillator section or otherwise rendering it inoperative. If functioning properly, there should be little or no difference in bias in any of the cases mentioned above, whether or not the oscillator is operating, except that resulting from the small change in cathode current—and then only when cathode bias is used.

6L7 Mixer Circuits

A typical 6L7 mixer circuit is shown in *Fig. 2.* This circuit is used in a standard communications receiver which is very efficient on short-wave reception. To overcome the reduction in sensitivity resulting from grid current in the 6L7, a high voltage is applied to the anode grid *No. 2.* This helps to prevent any excessive oscillator voltage from appearing on the control grid *No. 1.* Further, note that the 6J7 oscillator voltage is fed from the cathode tap to the injector grid of the 6L7. Normally greatest conversion gain is obtained when the oscillator voltage is high—greater than 18 volts—which would be obtained when making the connection to the oscillator grid, rather than to the cathode tap. However, by slightly sacrificing conversion gain in the mixer, the overall sensitivity is increased by minimizing the oscillator voltage which appears on the control grid. Further, there is less reaction on the oscillator circuit, due to the loading effect of the mixer, because the mixer circuit shunts only a portion of the oscillator circuit. This results in more even oscillator operation over a wide tuning range, greater uniformity of oscillation and, consequently, less variation in receiver sensitivity over the tuning range.

Diode Mixers

We get into the habit of thinking that either a pentagrid converter or a special mixer, such as the 6L7, is necessary for mixer or converter circuits. This is, of course, not the case. Even the simplest diode, as shown in *Fig. 3,* can serve as a mixer. In fact, for ultra-high-frequency work, it has certain advantages in reduced noise and partial elimination of transit time problems which make it well worth considering. Its limitation is that it is not possible to get any conversion gain from such a mixer. In fact, we are pretty certain to have a loss, since it is theoretically impossible to get any amplification out of a diode. A disadvantage of this circuit is that it places a load on the tuned circuit, at frequencies below 30 mc (approximately), which makes for broad tuning. On the other hand, at extremely high frequencies where the input impedance of the conventional mixer is very low due to electron transit time effects, the diode places less load on the tuned circuit. In experimenting with such a circuit, it will be noted that the oscillator voltage needs to be selected within a range which will give good sensitivity and low noise.

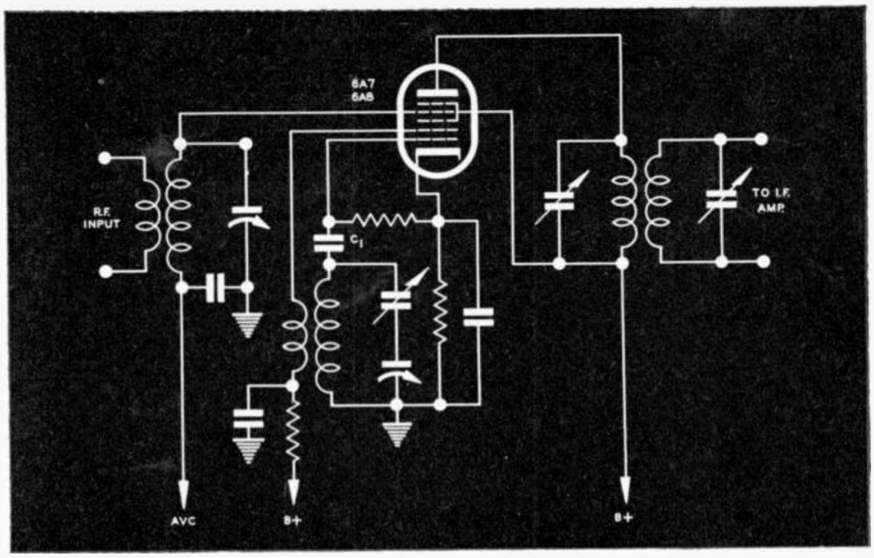


Fig. 4. A conventional mixer circuit which is very satisfactory at broadcast frequencies. A preamplifier may be added.

More conventional circuits are shown in *Figs. 4, 5* and *6.* In *Fig. 4,* the usual 6A7,6A8 circuit, employing a tickler-feedback oscillator coil circuit is shown. This is perhaps the most widely used arrangement in existence, and performs very well on the standard broadcast band. When r-f amplification is added, it does pretty well on short-wave reception, provided care is taken to avoid the detuning effects due to avc biasing on the converter grid. However, there is considerable reaction on the tuned circuit when the grid bias is changed, and this does require some attention, especially on short-wave bands. When this does not result in motor-boating, a peculiar tuning effect whereby the point of resonance is different when tuning from a lower frequency to the desired station than when tuning from a higher frequency to the same point, due to the change in frequency resulting from the change in avc bias which occurs when approaching the point of resonance of the desired station.

The single-ended 6SA7 converter circuit shown in *Fig. 5* has largely superseded the earlier 6A7 type illustrated in *Fig. 4.* The new circuit offers greater stability with variation in grid bias and, for frequencies up to about 6 mc, somewhat higher conversion gain. The latter is due to its excellent performance in conversion conductance at low voltages as compared with the 6A7, and, at the higher voltages, because of its higher plate resistance, if somewhat lower conversion conductance. It is adaptable to the Hartley circuit, as shown, and is consequently much simpler to handle for multi-band use than the more complex tickler-feedback circuit of the circuit of *Fig. 4.* The 6A7 may not be used with the Hartley circuit, because the arrangement of the grids is fundamentally different from that of the 6SA7.

To Increase Or Decrease Q

At very high frequencies, above 6 mc, it is more difficult to maintain even oscillation with the 6SA7 in use as a converter, but if a separate oscillator is employed, the 6SA7 will serve excellently as a mixer. Another advantage which this type of tube has at high frequencies is that the phase of the transit time effect is such that the Q of the input circuit is increased, making for sharper tuning and therefore better image frequency rejection, whereas with the 6L7 or 6J8 mixers the effect is to reduce the Q, broaden the tuning and decrease the image-frequency ratio. However, if a high avc voltage is applied to the control grid of the 6SA7, this advantage may be lost because of a change in phase of the input loading.

In using the 6SA7, it is important

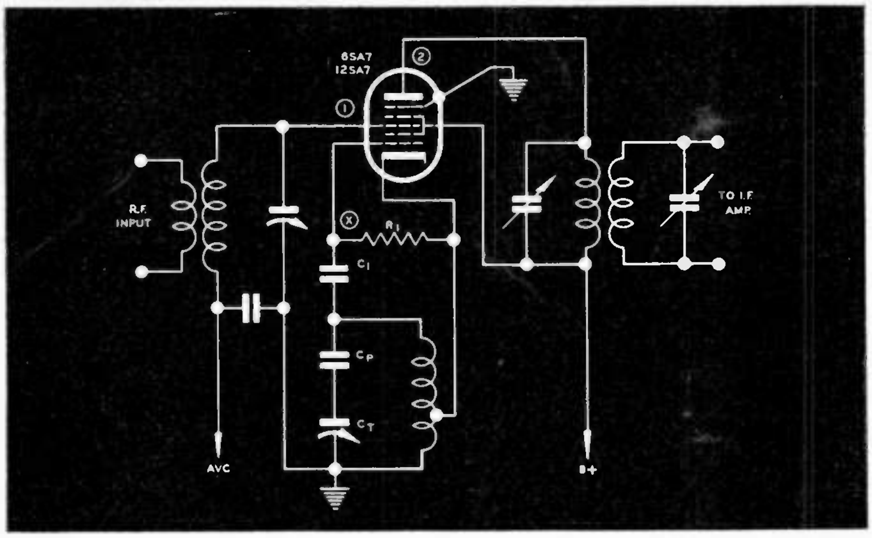


Fig. 5. Oscillator performance may be checked by measuring voltage across oscillator grid leak (point X to chassis).

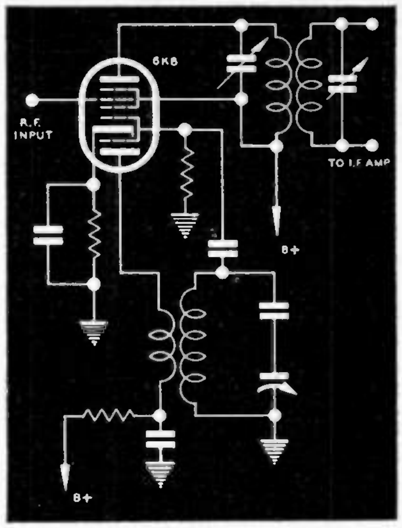


Fig. 6. The 6K8 is recommended as a converter in F-M receivers.

that the oscillator section develop sufficient depth of oscillation. Otherwise the grid may become positive with respect to the cathode over the negative half cycle of the oscillation. This may be overcome by substituting another tube, when the oscillator section has previously rendered satisfactory operation, or by moving up the cathode tap, if it is not possible to correct the condition by tube substitution.

The performance of the oscillator section of any of the converters may be checked by measuring the oscillator voltage developed across the oscillator grid leak, as at point (x) in *Fig. 5*. In operation, oscillation causes the oscillator grid to draw current, with the result that point (x) becomes negative with respect to the cathode. The voltage drop across the oscillator grid leak *R1*, thus measured, indicates the strength of oscillation. When the tuning is varied over the range, by turning the gang condenser, uniformity of oscillation is represented by an unchanging voltage across the oscillator grid leak. If at any time the oscillator grid leak voltage drops to zero, or becomes positive, we may be certain that the tube and circuit no longer oscillate. Thus "dead spots" in the tuning range may readily be detected.

Measuring Grid Voltage

The most convenient method of measuring the oscillator grid voltage is by means of an electronic voltmeter, fitted with a 1-megohm resistor at the probe point. The resistor serves to isolate the oscillator circuit from that of the probe cable of the electronic voltmeter, and thus prevents the detuning which otherwise would result from the use of such a cable.

However, if no such instrument is available, it is possible in some cases to use a 20,000-ohms-per-volt meter (with the series 1-megohm resistor at the test prod end) and to determine the relative voltage at any point in the tuning range. Alternatively, the resistor return circuit may be opened and an 0-1 ma meter may be connected in series with R1 and the cathode to which R1 otherwise connects. The voltage across the oscillator grid leak may then be determined by multiplying the resistance value of R1 by the current reading of the milliammeter.

The value of oscillator grid voltage thus measured varies considerably from one receiver to another of a different type. In general, the voltage will range somewhere between 5 and 30 volts negative. A carefully designed oscillator circuit will maintain a substantially uniform voltage throughout the tuning range of each band, but this is pretty hard to do on short-wave bands. In general, we should expect to find variations of 2 to 1 in most commercial receivers.

An important factor in making this test is to note if there are any dips or sudden peaks in the oscillator voltage, when tuning over the range. Such effects indicate absorption, generally caused by a wire becoming dislocated so it forms a resonant circuit which is within the frequency range of the set oscillator. Often this absorption will cause a "dead spot" in the tuning range—at best it will cause an increase in noise and reduce signal strength.

The conversion gain of a converter, is equal to the ratio of the signal voltage at the intermediate frequency developed across the primary of the intermediate frequency transformer, to the input r-f signal voltage. In most converters it ranges from 10 to 60. A low conversion gain is not necessarily indicative of poor design; in many cases, a slight sacrifice of conversion gain, particularly on short-wave bands, caused by reduced oscillator signal strength, may result in a lower noise level and therefore a better signal-to-noise ratio.

Converters for High Frequency

The 6K8 converter is designed particularly for very high frequencies, hence it has become a favorite in f-m receivers. It offers better conversion gain at such frequencies than any of the types heretofore discussed. It is subject to the same limitations as the 6A8, insofar as the tendency to motor-boating or "flutter" because of a change in grid bias, but the effect is not nearly so pronounced in the case of the 6K8. A regulated power supply, or a voltage regulator tube controlling the oscillator plate voltage, or, in many cases, just a good, big filter condenser—say 4-8 mf, bypassing the resistor in series with the oscillator B plus lead, will serve to eliminate any trace of motor-boating due to this cause. This applies in varying degree also to other converter tubes.

The 6J8G is another converter tube which has found some application, particularly in receivers with no r-f stage. It is said to have a somewhat lower noise level than the 6A8 and other similar types, but it is subject to the same difficulties as the others insofar as change in oscillator frequency with variations in avc voltage, though not to the extent present in the 6A8.

We have mentioned the use of a regulator tube to stabilize the oscillator plate voltage with changes in control grid bias of converters. The method of applying this control is indicated in *Fig. 7*. The voltage regulator may be any of the VR series which duplicates the operating voltage of the oscillator to be controlled, such as the *VR-75, VR-90, VR-105 or VR-150*. The *VR-105* gives the best regulation of the lot. The resistor *R* is chosen to limit the current through the voltage regulator to 30 ma when the applied voltage is as high as it ever will become. Control is then established within a few volts for all current down to about 5 ma, through the regulator.

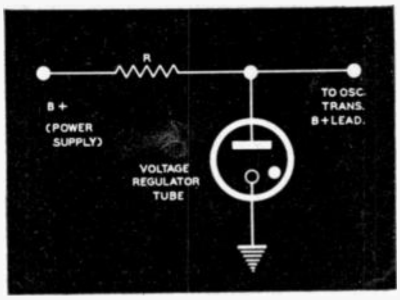


Fig. 7. Voltage regulator tube, employed to stabilize oscillator voltage.

Beat-Frequency Oscillators

In considering mixers and converters, it might be well to devote a little space to a discussion of mixers for beat-frequency oscillators. The problems involved are somewhat similar to those experienced in superheterodyne converters, but some points are of greater importance while others, such as avc control, do not enter into the picture at all.

One type of beat-frequency oscillator mixer is shown in *Fig. 8*. As illustrated, one frequency is fed directly to the triode mixer, while the other is picked up through a loosely coupled coil. In all beat-frequency circuits, extremely loose coupling is used from one oscillator to the one with which it beats, in order to avoid "pull-in" effects which otherwise occur when the frequencies closely approach each other. In *Fig. 8*, this is done by very loose indicative coupling. In the output circuit, a bypass condenser across the primary of the a-f transformer serves to reduce the r-f components of the beat-frequency oscillators, which usually operate around 100 to 350 kc. The transformer itself passes on the audio-beat frequency to the amplifier or output tube.

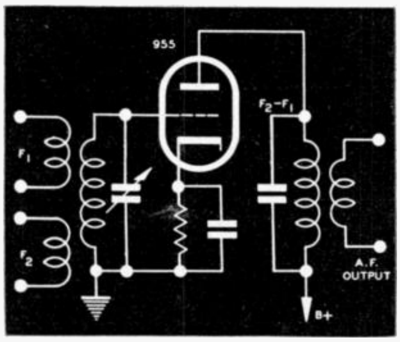


Fig. 8. Representative circuit of a beat-frequency oscillator mixer.

A variation in mixer design is shown in *Fig. 9*. Here the dual-triode 6A6 or 6N7 is represented, with one r-f oscillator feeding its output frequency *F1* to one grid, while to the other grid is fed *F2* from another oscillator of identical design. The small variable coupling condenser is adjusted so that the signal fed to one grid is much weaker—not greater than 10%—of that fed to the other. This prevents pulling in of the oscillators and assures better wave form at low beat frequencies.

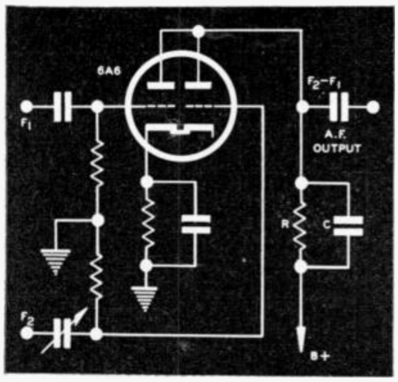


Fig. 9. Dual-triode tube employed to prevent oscillator "pull-in".

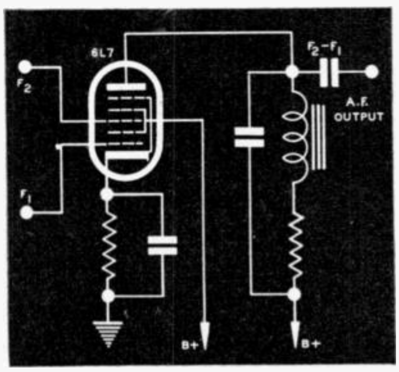


Fig. 10. Single-stage amplifier for correcting frequency discrepancies.

Using symmetrically designed r-f oscillators, any drift which should take place will cause, generally, a change in frequency of the same magnitude in the same direction. Under such conditions the resulting beat frequency remains the same. Actually, this is not realized in practice, but similarity in oscillator design does help greatly to improve beat-frequency oscillator stability.

One may wonder why the conventional mixer, type 6L7, shouldn't work out pretty well as a mixer for beat-frequency oscillators, and the answer is that it does. Provided one takes care that the signal *F2* fed to *grid No. 4* is considerably weaker than that fed to *grid No. 1*, good mixer action is assured, as well as good wave form in the output circuit. If *F2* is too weak, of course, the signal output will be very low, since this beat is equal to the product of *F1* and *F2*.

Different types of output circuits are shown in *Figs. 8, 9* and *10*. Any of these may be used interchangeably. That of *Fig. 10* lends itself to advantage in that the values of choke, condenser and resistance can be so chosen as to increase the gain over a portion of the range and thus compensate for any deficiencies in the amplifier, insofar as uniformity of output over the entire frequency range is concerned.

★

"MUSICAL NOTE STANDARD"

A true musical note broadcast continuously as a "purity" radio signal by the National Bureau of Standards plays a vital role in giving America's army, navy and air forces the world's finest communications equipment.

The meticulous Bureau of Standards, which zealously guards the integrity of America's official measurements, assists radio engineers to achieve that accuracy with its perpetual motion musical broadcast, which is accurate within 1 part in 10,000,000.

The pure "standard musical pitch," which corresponds exactly to the tone "A" above middle "C," is transmitted from the Bureau's Washington station WWV 24 hours a day. The musical note serves as a standard audio frequency of 440 cycles a second, and gives engineers an authoritative performance measure of such war-important radio equipment as quartz crystal oscillators, transmitters and receivers used on land, sea and air battle fronts. The engineers at Bendix Aviation Corp., Radio Division, among other radio companies for example, employ this "one note" musical program, in the fight against the Axis, to check laboratory apparatus employed in connection with radio equipment, etc.

RADIO SERVICE ENGINEERING

by Harold Davis*

THE ability to take a slide-rule or pencil and paper, and calculate the size of a needed component, is helpful to the radio serviceman even in normal times when his work is mostly mechanical; but in trying times like these, when the best of his ingenuity is needed to keep the nation's radio receivers playing, a working knowledge of simple radio formulas is a "must."

Most radio servicemen look on formulas as a necessary evil—something used only in school or by design engineers. Formulas are conceded to be either not practical or too complicated for everyday use.

Fundamental formulas are not complicated. They are very practical, simple to work, and once the serviceman understands how to interpret and apply them, he will derive much pleasure and satisfaction from his efforts.

Almost daily, servicemen now find it necessary to change circuits in order to use available parts. To the man who cannot check his work mathematically, these changes are guess work. The man who can may proceed with confidence, will know that he is giving his customer a good job.

Ohm's Law

The foundation of all radio engineering is Ohm's Law $E = I \times R$. A thorough understanding of this basic formula is a big step toward mastery of radio service engineering.

Ohm's Law states simply that it takes one volt to force one ampere through one ohm of resistance. Accordingly, if one ampere is flowing under the pressure of one volt, the circuit will contain *one ohm of resistance*. Likewise, if one ampere is flowing through one ohm of resistance, *one volt* will be developed.

Ohm's Law in action is best described by comparing it to a water system in which the voltage, *E*, is represented by the pump, the current, *I*, by the water that is flowing, and the resistance, *R*, by the pipe through which it is flowing. It can be seen from this that to increase the pressure at the pump is to increase the amount of water that is being forced through the pipe. It can also be seen that to increase the length of the pipe will reduce the amount of water flowing. Likewise, if another pipe is installed along side the first (in parallel) more water will flow under the same pressure.

This is exactly what happens in Ohm's Law. Resistance added to the circuit lowers the current flow. Parallel resistance increases the current flow because it lowers the resistance.

In attempting to apply Ohm's Law to their service work, most radio servicemen run into difficulty in substituting the correct values in the equations and in keeping up with the decimal point. Unfortunately, the Ohm's Law equations are in unit values, which is all right for volts and ohms, but in as much as the serviceman's current values are almost always in milliamperes (1/1000 of an ampere) this figure has to be converted to a decimal before it can be substituted in the formula.

OHM'S LAW QUICK REFERENCE CHART

Volts $= E = IR = \sqrt{WR} = W/I$
Amperes $= I = E/R = \sqrt{W/R} = W/E$
Ohms $= R = E/I = E^2/W = W/I^2$
Watts $= W = EI = I^2R = E^2/R$

To multiply by:	Move decimal:
10	1 place to right
100	2 " " "
1,000	3 " " "
10,000	4 " " "
100,000	5 " " "
1,000,000	6 " " "

To divide, move decimal indicated number of places to *left*.

CONVERSION OF POPULAR TERMS

Milliamperes — Amperes divided by 1000
Megohms—Ohms times 1,000,000
Milliwatts—Watts divided by 1000
Microfarads — Farads divided by 1,000,000
Micro-Microfarads — Microfarads divided by 1,000,000
Millihenry—Henries divided by 1000

Mathematical Equivalents

The amount of mathematics required to work practically any radio service engineering problem seldom exceeds that learned in the last grammar school years or the first high school grades. However, to most good servicemen such schooling happened long ago, and much of their knowledge has been forgotten. Accordingly, the mathematical explanations will be made whenever necessary in this series.

If the reader is not familiar with the rules for transposing equations, he should thoroughly memorize the following standard formulas:

$E = I \times R$	E = Voltage
$I = E/R$	I = Current
$R = E/I$	R = Resistance
$W = E \times I$	W = Watts.

In the first formula, the E is the voltage that will be dropped or de-

* Radio Engineer, Designer and Writer.

veloped when a current flows through a resistor.

In the second, the I represents the amount of current flowing when a voltage is applied to a resistor.

In the third, the R, is the amount of resistance encountered in the circuit by the current at a given voltage.

As previously explained, these formulas are for unit values only. When milliamperes are to be used, they must be reduced to a decimal, or, they may be used directly in the following formulas:

$$E = I \times R/1000$$
$$I = E/R \times 1000$$
$$R = E/I \times 1000.$$

Carrying the 1000 in the formula eliminates the decimal acquired when substituting milliamperes in the formulas. And, since any number may be divided or multiplied by 1000 by simply moving the decimal point to the left for division or to the right for multiplication, it adds no complications.

Also, in a majority of times, the zeros can be cancelled out. Example:

$$E = \frac{25 \times 5\not{0}\not{0}\not{0}}{1\not{0}\not{0}\not{0}} = \frac{25 \times 5}{1} = 125$$

or,

$$E = \frac{25\not{0} \times 5\not{0}}{10\not{0}\not{0}} = \frac{25 \times 5}{10} = \frac{125}{10} = 12.5$$

Reducing equations by cancellation is a most convenient procedure, and need not be confined to zeros.

Example:

$$E = \frac{25 \times 50 \times 35 \times 16 \times 24}{5 \times 10 \times 7 \times 4 \times 6}$$

$$E = \frac{\overset{5}{\not{25}} \times \not{50} \times \overset{5}{\not{35}} \times \overset{4}{\not{16}} \times \overset{4}{\not{24}}}{\not{5} \times 1\not{0} \times \not{7} \times \not{4} \times \not{6}}$$

$$E = \frac{5 \times 5 \times 5 \times 4 \times 4}{1} = 2000$$

Decimals, always confusing, may be eliminated in any formula by moving the point. Example:

$$E = \frac{3.5 \times .02 \times 10}{1000}$$

$$E = \frac{35 \times 2 \times 10}{1,000,000}$$

here the decimal was moved one place in 3.5 and two places in .02, or a total of three places. The same thing was done below the line, keeping equation in balance.

Referring to the formula $E = I \times R/1000$, the amount of voltage developed by 50 mils. flowing through 1000 ohms would be substituted as follows:

$$E = 50 \times 1000/1000$$
$$E = 50{,}000/1000$$
E = 50 volts (to divide by 1000 point off three places to the left of decimal).

This is the same as converting the milliamperes to amperes and substituting in the first formula as follows:

50 milliamperes = .05 ampere.
$E = .05 \times 1000$
E = 50 volts (to multiply by 1000, point off three places to the right).

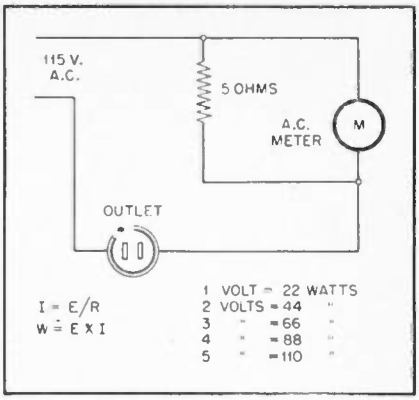


Fig. 1. Ohm's Law applied to resistive A.C. load.

A Practical Application

A practical application of the above equation follows: A screen-grid with 150 volts applied through a 500,000-ohm resistor had only 50 volts when measured with a high-resistance (20,000 ohms per volt) or electronic meter.

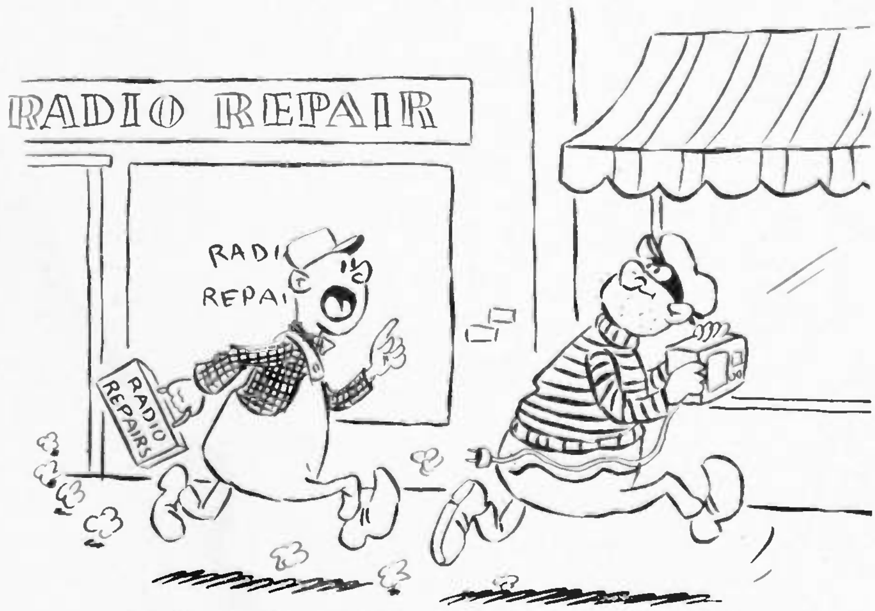
From a tube characteristic sheet it is learned that the screen should pull only .3 of a mil. with 100 volts reaching it. The question is, "How much voltage should be dropped across the resistor?" In the formula:

$$E = I \times R/1000$$
$$E = .3 \times 500{,}000/1000$$
$$E = 150{,}000/1000$$
E = 150 volts.

Now if 150 volts are dropped across the 500,000-ohm resistor 100 volts should be reaching the plate. If it measured only 50 volts with a high-resistance meter there is either an additional drain, caused, probably by a leaking bypass condenser, or the resistor has increased in value. Resistance measurements will give the answer.

Another practical application is where a 6F6 biased with a cathode resistor refuses to pass a signal. It is found that the plate and screen voltages are normal but the bias is high. The bias resistor is normal, 400 ohms. Checking in the manual it is found that the plate current for 250 volts should be 34 mils. with a screen-grid current at 6 mils. making a total cathode current of 40 mils. This should create a bias:

$$E = I \times R/1000$$
$$E = 40 \times 400/1000$$
$$E = 16{,}000/1000$$
E = 16 volts.



"I don't mind losing the set but I can't spare the tubes!"

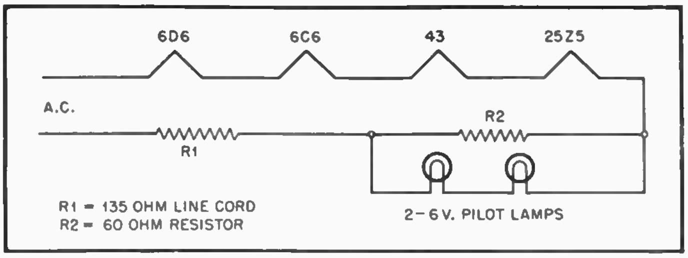


Fig. 2. Line voltage - dropping resistor supplies pilot lamp voltage.

If all other voltages are normal, the only thing that could cause a bias higher than the above value to be developed across the resistor is an increase in plate current. This in turn could be caused by a positive grid as the result of a leaking coupling condenser.

In extreme cases a shorted output transformer which would lower the load impedance might also result in increased plate current.

$$I = E/R$$

In the next equation we solve for the current value I. In order to use mils. directly we have to multiply our answer by 1000. A practical example of this formula is a very convenient way of determining the amount of "B" current being drawn by a set. If a set with a 1000-ohm speaker field or choke has a 50-volt drop across the choke, the amount of current being drawn from the rectifier is:

$$I = E/R \times 1000$$
$$I = (50/1000) \times 1000$$
$$I = 50 \text{ mils.}$$

The precaution in applying this formula is that the value substituted for E must be the actual voltage drop as measured across the choke only. Also, because resistance usually increases with heat, it is well to measure the resistance of the choke or field after it has been in operation for several minutes.

The drop across any one of the chokes or resistors will suffice for E, so long as the choke or resistor is in series with the entire "B" load.

Ohm's Law Limitations

Ohm's Law can be applied to alternating current so long as the R is purely resistive. Accordingly, a very simple and efficient wattmeter can be constructed using a rectifier-type a.c. meter and a 5-ohm resistor. The resistor is connected in series with the a.c. line; and the load *(Fig. 1)*, the a.c. voltmeter, which can be from 5 to 10 volts full-scale reading, is connected across the resistor. If the meter reads 4 volts when the lead is applied, the amount of current being "pulled" by the set is found by the formula:

$$I = E/R \times 1000$$
$$I = 4/5 \times 1000$$
$$I = 4000/5 \text{ or } 800 \text{ mils.}$$

Now, taking for granted that the a.c. line is the usual 115 volts, and that 5 volts, approximately, were lost in the resistor, a voltage of 110 was applied to the set. The watts power being pulled is the product of the voltage and the current:

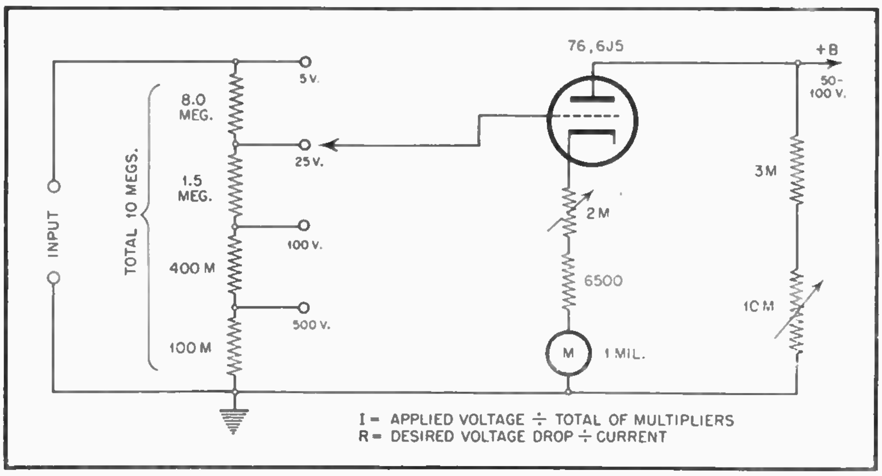


Fig. 3. Arrangement for adjusting meter to 5 volts full-scale (basic range).

$$W = E \times I$$
$$W = 110 \times .8 \text{ or } 88 \text{ watts.}$$

It will be seen that readings of 1, 2, 3, 4, and 5 volts will represent 22, 44, 66, 88, and 110 watts respectively. However, this is a volt-ampere meter instead of a true watt-meter; the figures will give watts only so long as resistive loads such as lamps, soldering irons, etc., are used. Radio sets will represent a slightly inductive load and the power factor will put the formula in error. However, a serviceman would use the device more for comparative measurements than anything else, and for this use the arrangement would be very satisfactory.

R = E/I

The most popular formula in the Ohm's Law series is the transposition that solves for the resistance, R. This formula,

$$R = E/I$$

is used to calculate bias resistors, voltage dividers, plate and screen resistors, and line cords for a.c.-d.c. sets.

Most radio men have taken a shot at figuring bias resistors, and those who have been unsuccessful can usually find their mistake is in not substituting the correct values in the formulas or in letting the decimal mix them up.

To find the size of a cathode resistor for a 75 tube we refer to the tube manual and find that a 75 with 180 volts on the plate draws .24 mils. and requires 1.3 volts bias. Substituting these figures in the formula we have,

$$R = E/I \times 1000$$
$$R = 1.3/.24 \times 1000$$
$$R = 1300/.24$$
$$R = 130{,}000/24 \text{ (multiply by 100 to remove decimal)}$$
$$R = 5000 \text{ ohms, approximately.}$$

It may be worth while to point out the procedure used above to eliminate the decimals. In line three the 1.3 was multiplied by 1000. In line four the .24 was made a whole number by multiplying both figures above and below the line by 100. The plate current here was only .00024 ampere.

Replacing Line Cords

Servicemen are often called upon to replace line cords and ballast tubes on a.c.-d.c. sets. Half the time the correct tube or cord is not available. The job can usually be completed with the facilities at hand if the size of the resistance needed to drop the line voltage to the correct value is known. A typical example follows:

If a set uses a 43, 25Z5, 6D6 and 6C6 tubes, the total voltage required to operate these filaments in series is 25 plus 25 plus 6.3 plus 6.3, or 62.6 volts. As most line voltages are 115, this leaves approximately 52 volts to be "lost" through a resistor in the ballast tube or line cord. Since the filaments are in series the circuit will draw 300 mils., the amount each tube would pull operated separately. (The current in a series circuit is always the same in each branch, but, remember, we said *series*.) If 52 volts are to be dropped in a circuit in which 300 mils. flows, the size of the resistor will be.

R=E/1 x 1000
R=52/300 x 1000
R=52,000/300
R=520/3 (both figures divided by 100)
R=173 ohms.

Most manufacturers would use 180 ohms to protect filaments against line surges. But suppose we had only a 135-ohm line cord. This would leave 45 ohms to be added. This could be added in the form of a resistor under the chassis, but the next question is, what size? This would require one of the power formulas, $W=I^2R$, being the most convenient (Power formulas will be taken up in detail later in this series.):

W=.300 x 45
W= .09 x 45
W=4.05 watts.

A 5-watt resistor should be OK.

However, what about pilot lights? Suppose two six-volt lamps had to be lighted. This would require 12 volts if they were operated in series. This suggests we utilize the voltage drop across the 45-ohm resistor *(Fig. 2)*. And to find out what voltage is being dropped across this resistor, we use the formula:

E=I x R/1000
E=300 x 45/1000
E=13,500/1000
E=13.5 volts.

This is a little high, but it must be remembered that when the pilot lamps are placed across this resistor, they are going to lower its effective resistance. Two brown-bead lamps have a resistance of (their combined voltage, divided by the current rating of one, which is 150 mils.):

R=(12/150) x 1000
R=12,000/150
R=1,200/15 (divided by 10)
R=80 ohms.

If 80 ohms are shunted across 45, the resultant resistance would be less than 30 ohms. (How to figure parallel-series networks will be taken up later.) This value is low, and so, the value of the 45-ohm resistor can be increased to 60 ohms and the resultant resistance will be approximately 40 ohms, which will be high enough for a filament series resistor, and will give a voltage drop of 12 volts for the series pilot light.

The only other consideration now is what happens if one of the lamps burns out. This will put 600 ohms in series with 135, or 195 ohms. The total voltage drop across 195 ohms at 300 mils. is:

E=195 x 300/1000
E=195 x .3
E=58.5 volts.

This means that an excess of 6.5 volts is being dropped, but this amount is negligible for series operation.

Extending Voltage Ranges

Most any radioman can recall times when he needed to read a voltage beyond the range of his voltmeter. It is a very simple matter to extend the range of a meter.

Most meters on the market today have either a one mil. or 500 microampere movement. This means that one or one-half milliampere, respectively, flows when the meter reads full-scale. A one-mil meter reading 500 volts will require a series resistor (multiplier) of

R=E/I x 1000
R=500/I x 1000
R=500,000 ohms.

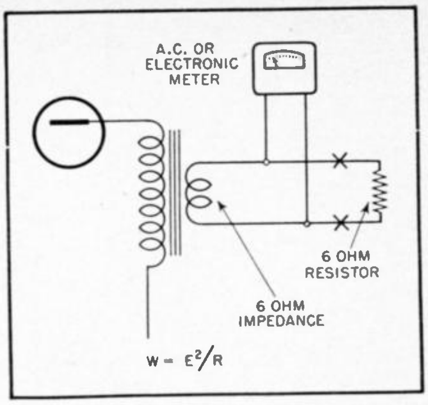


Fig. 4. Output load resistor should match transformer secondary impendance.

Now if the range of this meter is to be extended to 1000 volts the resistance required would be,

R=1000/I x 1000
R=1,000,000 ohms or 1 megohm.

Since there is already a ½-meg. resistor in the circuit (for a 500-volt reading), an external, 500,000,-ohm resistor in series with the 500-volt range will extend this scale to 1000 volts, thereby doubling the range. Any reading on the meter, with the resistor in series, then will be twice the meter indication.

Electronic Voltmeter Multipliers

Along this same line is the procedure for calculating the voltage divider or multipliers used on the popular electronic voltmeters incorporated in the signal tracers on the market. These multipliers consist

"Tell your old 'London Calling' to put a hot platter on the air, will yuh bub?"

of a series of resistors, the total of which is predetermined by the over-all sensitivity of the instrument. A total of ½-meg. would make this a 1000 ohms-per-volt meter at 500 volts. However, these meters must have much higher sensitivity than this, and so, a value of two meg-ohms-per-volt on the lowest range is used by a number of manufacturers. This range permits measuring a.v.c. and bias voltages, and still is low enough to insure stability, an important factor.

If a value of two megs. per-volt is chosen, the total of the multipliers will be 10 megs., for a 5-volt scale. The value of the first multiplier is found by dividing the current in the circuit into the applied voltage. If the scales are to be 5, 25, 100, and 500, as are commonly used, the 5-volt range is the base scale, and the meter circuit is adjusted to read 5 volts full-scale by adjustment of bias and plate voltage. See *Fig. 3*. For the second range, 25 volts, 20 volts must be dropped before the tube grid is reached. To calculate this resistor, the total amount of curent flowing in the entire 10 megs. must be found. This is,

$I = E/R \times 1000$
$I = 25/10{,}000{,}000 \times 1000$
$I = 25{,}000/10{,}000{,}000$
$I = .0025$ milliamperes. (To divide by 10,000,000, point off 7 places to left).

The size of the resistor to drop 20 volts at .0025 ma. current is

$R = 20/.0025 \times 1000$
$R = 20{,}000/.0025$
$R = 200{,}000{,}000/25$ (multiply both figures by 10,000)
$R = 8{,}000{,}000$ ohms.

The first tap of the divider or multiplier is 8 megs.

The next range is 100 volts, of which 95 volts must be dropped at the second tap. The current that flows when 100 volts is applied across the multiplier is,

$I = 100/10{,}000{,}000 \times 1000$
$I = 100{,}000/10{,}000{,}000$
$I = 1/100$ (dividing both figures by 10,000)
$I = .01$ milliamperes.

The resistance necessary to drop 95 volts at .01 mils. is

$R = 95/.01 \times 1000$
$R = 95{,}000/.01$
$R = 9{,}500{,}000$ ohms (To divide by .01, simply add two zeros).

Since there is already 8 megs in the first section of the multiplier, the second section will contain 9.5 megs. less 8 megs., or 1.5 megs.

The third section will be found the same way, using 500 volts for E in determining I, and then using 495 volts for E when solving for R. This will give 9,900,000 ohms, from which is subtracted 8 megs. and 1.5 megs. leaving 400,000 ohms for the third section of the multiplier. The bleeder which is the lower end of the multiplier is the difference between the sums of the multiplier, 9.9 megs and the total resistance of the divider, 10 megs. This is 100,000.

Any value may be used for the total resistance of the divider, but 15 megs. is the highest any manufacturer uses. Any series of ranges may be figured by following the pattern illustrated above.

Power Output

Calculating power output of an audio amplifier is not involved in a lot of db.'s and square roots as some servicemen seem to think. A couple of simple measurements and substitutions in one of 3 popular power formulas is all that is necessary. These formulas are,

(*Continued on page 22*)

Shop Notes

Data presented as "Shop Notes", contributed by service-dealers as a result of practical experience, is carefully considered before acceptance. We believe it correct but we assume no responsibility as to results.

Card 1

MAJESTIC 330

(Circuit Revision)

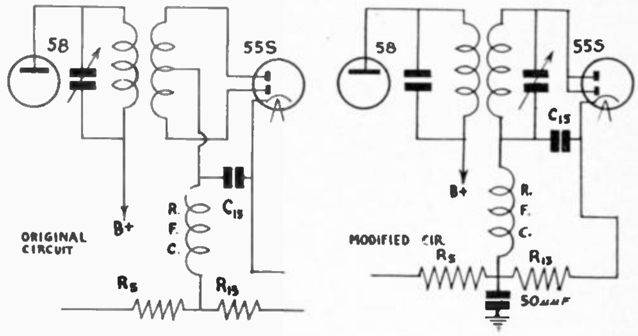
This receiver uses a special i.f. transformer, working into the 2nd detector, which is often unavailable due to parts shortages. The original push-pull circuit can be changed satisfactorily to a half-wave, as shown in adjacent Card No. 2. A boost in volume results due to the resonant action, with the secondary of the new coil being tuned. In some cases it is necessary to add a small capacity, about 50 mmf, from the junction of R5 and R13 to ground, to improve stability and ensure freedom from regeneration. The diode load, R13, may have to be changed in some sets, to a value of about 100,000 to 250,000. If the audio input tends to be too high or strong stations, increased bias on the 1st audio tube will prevent distortion. A vacuum tube voltmeter is handy for checking the signal levels.

Submitted by Willard Moody

Card 2

MAJESTIC MODEL 330

(Circuit Revision Schematic)



Card 3

GENERAL ELECTRIC LB-530

(Battery refuses to charge)

Preventing the building up of a charge was a short circuit across the B supply, due to a breakdown in the i.f. transformer from the plate winding to the grounded secondary winding, causing grounding of the plate winding. New i.f. transformer cured the condition.

Submitted by Willard Moody

Card 4

6A7 TUBES FAIL TO OSCILLATE

Many 6A7 tubes fail to oscillate on the low end of the dial but operate satisfactorily on the high end. This is particularly true in Chevrolet auto-radio model 985301.

When the tube and circuit check "ok," if the cathode is connected directly to ground, the trouble will be eliminated.

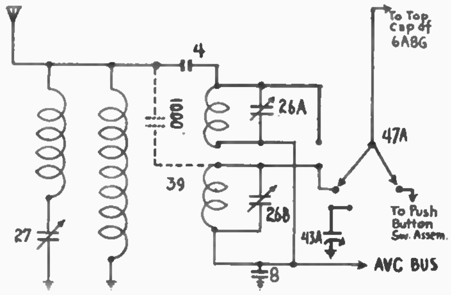
Submitted by J. E. Simmons

Card 5

FIRESTONE CHASSIS R-314

Complaint: Poor sensitivity on broadcast band.

Remedy: add .0001 mfd mica condenser, connected as shown in the accompanying schematic; ratio of sensitivity improvement, 10 to 1.



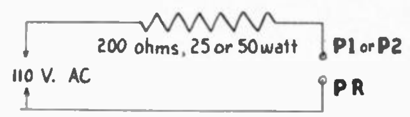
Submitted by G. Franklin Hill

Card 6

VIBRATORS—STARTING FAILURE

New vibrators taken from stock sometimes fail to start upon installation merely because an oxide coating has formed on the points. To eliminate this oxide coating is a simple matter.

Connect 110 volts AC through a 200 ohm, 25 to 50 watt resistor to the reed (PR) and to either point P1 or P2 of the vibrator. Only one of the latter will draw current and actuate the reed. With the vibrator held so the prongs face you, determine the location of the prongs connected to RP, P1 and P2 as illustrated.



Usually from 1 to 10 seconds are required to start the vibrator running and remove all oxide film from the points. This will not damage the vibrator.

From Radiart Corp. Service Bulletin JV211

Card 7

WELDING OLD TUBE FILAMENTS

(Also radio coils and speaker fields)

The filaments in many damaged tubes in the 12 to 50 volt group can be successfully welded with an arc formed by a spark coil from a Model T Ford.

Solder wires to the 4 contacts on the spark coil. Run 2 of these to a storage battery. To complete the weld touch the other two wire leads across the base of the tube which shorts the filament in most instances.

The same practice may be used on open coils or speaker field coils.

Submitted by Kirk's Radio Service Co.

Card 8

TRUETONE MODELS D-906; D-911B; D-924; D-925

Dial Pointer Sticks

The celluloid diffusing plate protrudes and interferes with pointer operation.

1. Remove tuning shaft bracket, diffusing plate and four screws holding dial frame.
2. Place diffusing plate between dial frame and dial frame support brackets.
3. Insert the fasteners from the back to hold the diffusing plate in place using the same holes.
4. Replace tuning shaft bracket.

Submitted by Kenneth Tusar

RADIO SERVICE ENGINEERING

(Continued from page 20)

$$W = E \times I$$
$$W = E^2/R$$
$$W = I^2R.$$

Of these, the $W = E^2/R$ is usually the simplest for the serviceman, as it is more convenient for him to measure voltage and resistance.

To measure the output from a radio or amplifier, connect a resistor of the same size in place of the speaker voice coil. *(In Fig. 4).* The resistor should match the voice coil impedance, not the d.c. resistance. Feed an audio signal into the instrument and measure across the resistor with a rectifier type a.c. meter. An electronic meter may also be used. If the reading is 5 volts, the power output is,

$$W = E^2/R$$
$$W = 5 \times 5/6$$
$$W = 25/6 \text{ or } 4.01 \text{ watts.}$$

Probably the most popular of the power formulas is the $W = I^2R$. With this formula, the watts rating of a resistor required in a circuit may be found. If two 6L6's are to be cathode biased they will require a 120-ohm resistor. To find the necessary rating of this resistor, the cathode current, which is the sum of the plate and screen current must be known. Referring to a tube manual this is found to be 130 milliamperes, or .130 amps. Substituting in the formula.

$$W = I^2 R$$
$$W = .130 \times .130 \times 120$$
$$W = .0169 \times 120$$
$$W = 2.028 \text{ watts.}$$

If it is desired to replace a volume control of the screen-grid bleeder type with a carbon replacement, where the original was a wire-wound, it might be necessary to know how much power the control has to dissipate to see if it is safe to install the carbon. If the screen current of the tube is 5 mils. and the volume control 100M. the power dissipation of the control is,

$$*W = I^2R$$
$$W = \frac{5 \times 5 \times 100{,}000}{1{,}000{,}000}$$
$$W = \frac{25 \times 100{,}000}{1{,}000{,}000}$$
$$W = \frac{25}{10} \text{ (dividing both figures by 100,000)}$$
$$W = 2.5 \text{ watts.}$$

However, the control would not have to be 2.5 watts, because as the amount of screen voltage is decreased by increasing the resistance of the control in series, the current falls off until it will reach a figure probably only one-fifth of the normal value.

When the screen current is 5 mils. only a small portion of the control will be in the circuit. If this amount is, say 10,000 ohms, the power dissipation will be only

$$W = \frac{I^2R}{1{,}000{,}000}$$
$$W = \frac{5 \times 5 \times 10{,}000}{1{,}000{,}000}$$
$$W = \frac{25}{100} \text{ or .25 watts.}$$

Every serviceman knows that a light bulb makes a good high-watt resistor in an emergency. To find the resistance of lamps when their rating is known requires the use of a transposition, of the power formulas, not yet discussed. This formula is, $R = E^2/W$. Substituting in this formula, a 100-watt lamp would have resistance of,

R = $110^2/100$
R = $110 \times 110/100$
R = 110×1.1
R = 121 ohms.

Similarly, a 60-watt bulb has,

R = $110 \times 110/60$
R = 216 ohms, approximately

A 25-watt, 32-volt bulb has,

R = $32 \times 32/25$
R = 41 ohms, approximately.

The next article in this series will take up more complicated forms of Ohm's Law as applied to radio servicing.

---

* To substitute milliamperes in this formula it is necessary to use this transposition,

$$W = \frac{I^2R}{1,000,000}$$

The reason 1,000,000 must be used instead of 1,000 as formerly, is because the current must be squared. The square of 1,000 is 1,000,000. After the current in milliamperes has been squared and multiplied by the resistance, the decimal can be moved 6 places to the left which divides it by 1,000,000.

A slide rule is most helpful in solving these problems, particularly in finding squares and square roots. To square a number on the slide rule, simply find the number on the D scale and read the answer directly above on the A scale, or vice versa for square roots, with the exception that all odd digit numbers are set on the first part of the A scale and all even digit numbers on the second. Example: 9, 125, 25,000 are odd, and must be set on the first part of scale A.

Slide rules, quite dependable yet inexpensive (25c), are sold at most dime stores and stationery counters. The slide rule takes the drudgery out of working problems, and is very easy to use.

★

CIRCULAR SLIDE-WIRE RHEOSTAT

Designed especially for low-resistance, low-power applications, this rheostat-potentiometer (and voltage divider) has found several applications in the instrument field.

A length of resistance wire is stretched tightly around the outside of a cylindrical core which is bonded to a ceramic base. The wire is firmly anchored to two of the three terminals. Contact to the wire is made by a phosphor-bronze spring arm, which slides over the wire.

The maximum resistance which can be supplied on this unit is approximately 0.1-ohm. Shafts for knob control or for screwdriver control can be supplied. These units are made to order to suit the particular application, and inquiries on this basis are welcomed. Ohmite Mfg. Co., 4847 W. Flournoy St., Chicago, 44, Ill.

Tom White, vice-president of Jensen Radio Mfg. Co. plays host to Sgt. J. E. Barry, U. S. Marine Corps, who was on the Wasp when she went down, and who also was one of the first Marines to land on Guadalcanal. With them are Firemen 1st Class A. W. Ambler, U.S.N. who was aboard the Lexington and Yorktown when each was sunk, also Yeoman Shelby Pitts.

Wave Meters

IN this global war, Army and Navy radio transmitters have to work equally as well in the frozen Arctic as in the steaming tropics. But to do this, they have to be adjusted accurately for the effect of changes in temperature and humidity.

For this purpose, a wave meter is used — an intricate device against which the wave length of the transmitting set can be checked and corrected.

Unfortunately, the same atmospheric conditions that knocked radio transmitters off their wave length did the same thing to wave meters. In fact, these meters could be exactly calibrated the day they were manufactured, and then be grossly inaccurate 24 hours later, if there was a marked change in the weather.

Philco engineers and production experts wrestled with this problem for an extended period, finally concluding that some change in the construction of the wave meter would be necessary to make it "weatherproof."

By introducing a thermostatic control into the radio circuit of the wave meter, they worked out a self-compensating device in which the effective length of the wire in the control coil was increased or reduced, as temperature varied, to maintain the same exact wave length at all times. The principle adapted to this essential war service is similar to that used in thermostats for automatic heating in thousands of American homes.

Chief credit for this engineering contribution goes to E. O. Thompson, Philco Engineering Department, and David Sunstein of the Philco Factory Organization, who were officially cited for their work by the Board for Individual Awards of the War Production Board.

★

Book Review

RADIO DATA HANDBOOK, edited by Lieut. Nelson M. Cooke, United States Navy, published by Allied Radio Corp., 833 W. Jackson Blvd., Chicago. Forty-eight pages, 6" x 9". Price, 25c.

A comprehensive, condensed handbook of formulas, charts, and data most commonly used in the field of radio and electronics. All subjects are clearly presented and conveniently arranged and cross-indexed for ready reference.

Divided into four parts: Mathematical Data, Radio and Electronic Formulas, Engineering and Servicing Information, and a complete set of four-place Log and Trig Tables.

Formulas are given for Decibels, Resistance, Capacitance, Inductance, Reactance, Resonance, Frequency, "Q" Factor, Impedence, Conductance, Susceptance, Admittance, Transients, Peak Average and R.M.S. Voltage and Current Values, Meter Shunts and Multipliers, Vacuum-Tube Constants, etc.

Data section contains such subjects as Radio Color Codes, Interchangeable Tubes, Pilot Lamps, Plug-in Ballast Resistors, Coil Winding, and others.

An exceptionally useful and well-prepared book that should aid the student learning useful fundamentals, the serviceman who wants technical and maintenance data, the experimeter who wants nomographs, and practical information, and the engineer seeking a time-saving reference.

★

STANCOR APPOINTS BURCHAM

Standard Transformer Corporation announces the appointment of Don H. Burcham, 917 S.W. Oak Street, Portland, Oregon, as their representative covering jobber and industrial sales in the states of Idaho, Montana, Oregon and Washington, effective June 1, 1943.

BOOK ON RADIO OPERATIONS

A book on radio communications, designed specifically to enable a person to pass the Federal Communications radio examination, has just been completed by Frank Melville, Jr., noted aircraft radio technician and director of the Melville Aeronautical Radio School. It is the first book of its kind and will be published for Fall release. Three prominent publishers are now bidding for the rights.

Says Mr. Melville: "This book which will contain 450 to 500 pages fills a definite need in the ever growing field of radio communications. It is, however, not intended for the sudden war market created in this field but for the men and women who plan to make radio communications their life's work."

According to the recent survey, over 100,000 post war jobs will be available in the field of radio communications. Schools now teaching this subject are without a comprehensive text book, covering all phases of the work. This new book of Melville's is expected to fill that gap.

★

LT. COMDR. BRENGLE UPPED

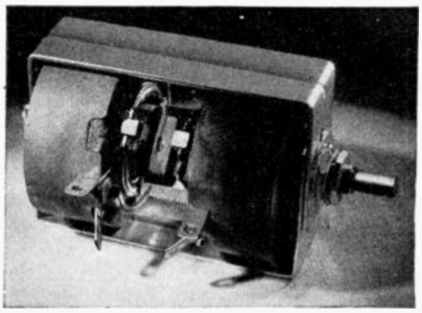
Lt. Comdr. Ralph T. Brengle, formerly Head of Radio Procurement Section, Bureau of Ships, has been appointed Assistant Head of Radio Division, Bureau of Ships.

Before entering the service Lt. Comdr. Brengle was head of the Ralph T. Brengle Sales Company of Chicago and is widely known in the radio industry.

★

TANDEM POWER RHEOSTATS

Compact, sturdy tandem power rheostat assemblies of two or more sections are announced by Clarostat Mfg. Co., Inc., 285-7 N. 6th St., Brooklyn, N. Y. These assemblies are made up of two 25-watt or two 50-watt rheostats rigidly coupled together and held in a metal cradle. The usual one-hole mounting and locking-projection features are retained. The individual rheostats can be of any standard resistance value, taper, tap and hop-off, and all units go through the same degree of rotation as the single shaft is turned. The units are fully insulated from each other and from ground. Because of the wide choice of resistance values and other factors, such assemblies are necessarily made only on special order.



★

MOTOROLA EARNS STAR

One of the first Chicago firms to be awarded a star on their Army-Navy "E" flag, for continued excellence in production, is the Galvin Mfg. Corporation, 4545 Augusta Boulevard.

The facilities of Galvin, peacetime makers of Motorola home and car radios, are now devoted 100% to the production of radio equipment of all kinds for every branch of the armed forces.

Shop Notes

Data presented as "Shop Notes", contributed by service-dealers as a result of practical experience, is carefully considered before acceptance. We believe it correct but we assume no responsibility as to results.

Card 1

ATWATER-KENT MODEL 145

(Gain Data)

Tune receiver, Sig. Anal. and Sig. Gen. to 600 kc. Tune receiver for *peak* on Analyzer's indicator. Tuning conds. must be rocked for *peak* on all tests except oscillator.

2A7	osc. mod.	grid	.4		600 KC
2A7		plate	1100.0	osc. freq.	864 KC
2A7		plate	97.0	IF freq.	264 KC
58	IF amp.	grid	31.0		264 KC
58		plate	2300.0		264 KC
2A6	diode	plate	1700.0		264 KC
2A7	triode	plate	12.5	volts 400 cps.	
2A5	output	grid	10.0		
2A5		plate	120.0		

Submitted by Robert Boudreaux

Card 2

AIRLINE MODEL 5B17

(Gain Data)

Tune receiver, Sig. Anal. and Sig. Gen. to 600 kc. Receiver must be tuned for *dip* on indicator, and sensitivity control set on "distance" position. Rock tuning conds. for *dip* on all tests except oscillator.

Ant.	through .0002 mfd.		1.0		1000 KC
1A7G	osc. Mod.	grid	22.5		1000 KC
1A7G		plate	60.0	osc. Freq.	1455 KC
1A7G		plate	120.0	IF freq.	455 KC
1N5G		grid	57.0		455 KC
1N5G		plate	3400.0		455 KC
1H5G	diode	plate	2500.0		455 KC
1H5G	triode	plate	15.0	400 cps.	
1A5G	output	grid	14.0		
1A5G		plate	57.5		
AVC	at vol. cont.		12.0	DO	

Submitted by Robert Boudreaux

Card 3

TRUETONE MODEL D-925-B

Weak Reception

Reverse the connections to the primary of the broadcast preselector (L^1) and attach outdoor antenna.

Submitted by Kenneth Tusar

Card 4

12A8 G/GT SUBSTITUTED FOR 12SA7 G/GT

Take lead #8 grid prong off 12SA7 socket and run it to grid cap of 12A8.

Disconnect all leads from #6 prong of 12SA7 socket and connect them to #8 prong. Leave #6 prong blank.

Realign I.F. or use tube shield, or both.

Submitted by W. G. Auringer

Card 5

ELIMINATING HUM IN AC/DC SETS

When AC/DC sets warm up and develop a bad hum plus distortion the fault usually cannot be eliminated by using filters. However, by substituting a 50L6GT for the 35L6GT the hum will disappear, tone improve, tubes last longer. There is no appreciable loss of volume.

Submitted by Marsh Electric Shop

Official U. S. Signal Corps Photo

ELECTRONIC CHECKUP OF CONTROLS

Every Clarostat control coming off the production line is checked by cathode-ray it is now disclosed. This precision test has been practiced as standard Clarostat production routine for several years and, in conjunction with the development of the stabilized coated element for composition-element controls, is responsible for a uniformity of product.

In the cathode-ray or electronic checkup each control is placed in turn in a fixture wired to the cathode-ray tube. As the operator swings a lever on the fixture, the vivid dot trace meanders diagonally across the screen in response to resistance vs. rotation. At a glance the inspectors have "all the answers," as Chief Engineer George J. Mucher puts it. Resistance curve, taper, hop-off, transition points or ink blends, flaws or cracks, potential noise sources, comparative resistance values, useful rotation, grounds, etc. are checked visually, positively, quickly, and far better than with the usual earphone test. Such factors as resistance curve, taper, hop-off and transition points can be held to within narrow tolerances by respective markings on the cathode-ray tube screen. The trace provides far more data than would be furnished by a large variety of meters, earphones, neon bulbs and other indicators usually employed in such production checkups.

★

SYLVANIA EARNINGS INCREASE

Sylvania Electric Products Inc. for the first quarter of 1943 reports net earnings of $341.122 after all charges and provision of $1,142.040 for Federal taxes on income and the setting aside of reserves for possible adjustments due to renegotiation of contracts and revision in Federal tax rates. The figures as stated are from the books of the company and are subject to the usual audit and year-end adjustments.

After allowance of $35,810 for dividends on the preferred stock, which has been called for redemption on June 5, these earnings were equivalent to 59 cents per share on 520,518 outstanding shares of common stock. The 1943 earnings compare with earnings of $284,976 in the corresponding period of 1942 after provision of $664,960 for Federal taxes on income, equal, after allowance of $37,656 for preferred dividends, to 48 cents per share on 514,368 shares of common stock then outstanding.

$1.00 PAID FOR SHOP NOTES

Write up any "kinks" or "tricks-of-the-trade" in radio servicing that you have discovered. We will pay $1 in Defense Stamps for such previously unpublished "SHOP NOTES" found acceptable. Send your data to "Shop Notes Editor," RADIO SERVICE-DEALER, 132 W. 43rd St., New York, 18, N. Y. Unused manuscripts cannot be returned unless accompanied with stamped and addressed return envelope.

NEW OUTDOOR P-E RELAY

A new general-purpose photoelectric relay for outdoor use has been announced by the Electronic Control Section of the General Electric Company. Designated as the Type CR7505-K108, it is for applications requiring rapid and accurate counting, controlling, sorting, or limiting operations. Its contacts control 2 amperes at 115 volts, 25- to 60-cycles, alternating current, or 0.5 amperes at 115 volts, direct current.

In addition to a Type GL-930 phototube, the new relay contains a Type GE-117P7GT pliotron tube. Its filament operates on full line voltage, eliminating the filament transformer. It incorporates a diode rectifier which functions when a-c power supply is used.

The relay can be mounted in any position and can be adjusted under actual operating conditions, without removing the cover. The chassis can be removed easily from the case for inspection or servicing or, if desired, for mounting with other apparatus in a combination enclosure.

Bulletin GEA-1755E gives details on this and other photoelectric relays.

★

NEW BATTERY CHARGING GENERATOR

»» A new Portable Gasoline Driven Generator, for rapid battery charging is announced by Hunter - Hartman Corp. of St. Louis, Missouri.

Portable Gasoline Engine Driven Generator

The equipment is designed to charge 6 - 12 - 24 volt batteries at 10 to 300 amperes, and consists of a specially designed generator driven by a 6 HP single cylinder, air cooled, gasoline engine which is equipped with air cleaner, gasoline filter, magneto, self-starter, rope starter, gas tank and remote stop control.

For easy portability, the entire unit is mounted on a skid-type base, equipped with 5 inch wheels. When the unit is in use the wheels are raised from the ground, thus preventing creeping. Reasonably fast delivery can be made on AA5 priority.

Moving Soon?

Notify RADIO SERVICE-DEALER'S circulation department at 132 West 43rd Street, New York, 18, N. Y. of your new address 2 or 3 weeks before you move. The Post Office Department does not forward magazines sent to a wrong address unless you pay additional postage. We cannot duplicate copies mailed to your old address. Thank You!

War-time Battery Arrangements

BECAUSE of war-time requirements, battery suppliers are limited to produce only 30% as many "A-B" battery packs as in 1940.

No more packs are being built for portable receivers; production of packs is limited to those used with farm type receivers, but the fact still remains that there will be only one pack available for every three of these radios in use.

Fortunately, in almost every case, a radio set designed to use a combination "A-B" pack can be adapted to take separate "A" and "B" batteries. The production of these has also been curtailed, but, in most localities, they are more likely to be available than is the case with combination "—B" packs.

It is suggested that you contact your local radio supplier, or one of the large mail order houses, to ascertain if they have these batteries available.

All Crosley battery-type receivers are equipped with a color-coded cable and plug. It will be advisable to remove the plug and extend the length of these colored wires sufficiently so that general replacement-type batteries may be easily connected. When making these extensions, use ordinary *insulated* copper wire, and *carefully tape* all joints. The batteries you may obtain may not be of a size that will permit installation inside the radio cabinet, but at least operation will be restored.

Table I lists the various Crosley Packs, with all pertinent information.

Notes: It is always advisable that batteries be connected by someone familiar with this type of work. Remember that "A" battery voltages are *very critical* and no attempt should be made to use other than an "A" battery of the specified voltage. However, if a single 6 volt "A" battery is not obtainable, four 1½ volt "A" batteries may be used; or in the

TABLE 1.

Pack No.	*Voltage* A	*Voltage* B	*Cable Color Code* Black	Red	Yellow	Blue	*Used on Model No.*
CR28 CR60 CR69	1.5V	90 V	—A	+A	—B	+B	B449A, B459A, B579A, B5579M, B6579D, B589A, B5589B, B36BS, 36AM, B36BS, 43FA, 53FA, 53FB Farm Sets
CR61	6 V	90 V	—A	+A	—B	+B	43BT Farm Set
CR57	6 V	90 V		+B	—A—B	+A	52FA, 52FB, 52FC Farm Sets
CR58	7.5V	90 V		+B	—A—B	+A	62FA, 62FB Farm Sets
CR49	1.5V	67.5V	—A	+A	—B	+B	B439A Portable
CR649	6 V	67.5V	—A	+A	—B	+B	B549A, B549B, B549C Portable
CR67	6 V	75 V		+B	—A—B	+A	52PA, 52PB Portable
CR68	7.5V	75 V		+B	—A—B	—A	62PA, 62PB Portable
CR658	6 V	90 V	—A	+A	—B	+B	27BD, 27BE Portable

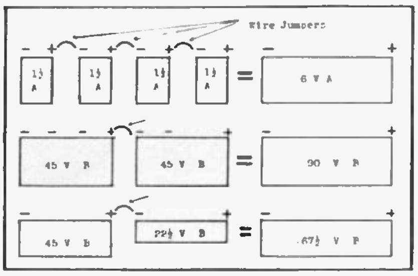


Fig. 1. Circuit arrangements for "A" and "B" batteries connected in series.

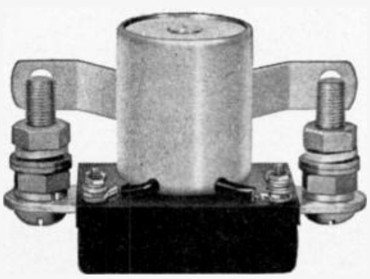
case of a 7.5 volt "A" battery being required, five 1½ volt "A" batteries may be used.

If a single 90 volt "B" battery is not obtainable, two 45 volt "B" batteries will be a proper substitute. If a single 67.5 volt or 75 volt "B" battery is not obtainable, one 45 volt "B" battery and one 22.5 volt "B" battery will suffice. Fig. 1 illustrates how the various types of hookup should be handled.

★

LIGHT WEIGHT AIRCRAFT SOLENOID CONTACTOR

» The new type B-8 solenoid contactor produced by Guardian Electric meets U. S. Army specifications for remote control of aircraft engine starter motors. It performs a function similar to that of the type B-4 contactor with which it is interchangeable on intermittent duty applications. The contacts on the B-8 solenoid contactor close firmly at 6 volts, whereas on the B-4 type, 18 volts are required.



The B-8 complete with terminal bolts, nuts and washers, weighs approximately three-quarters pounds less than the B-4 unit and it is a single pole contactor with double break normally open contacts, so constructed that the contacts do not chatter as a result of voltage drops caused by starting motor current surges. Contacts are rated at 200 amperes. The B-8 operates at 24 volts dc, intermittent duty. At 24 volts the coil draws 3 amperes. Vibration resistance exceeds ten times gravity. Similar contactors, built for continuous duty, are types SC-25 and SC-45. For further details write Guardian Electric, Dept. 8, 1637 West Walnut Street, Chicago, Ill.

L. K. Marshall, president of Raytheon, making speech of acceptance upon presentation of Army-Navy "E" Awards to the power-tube, small tube, radar and equipment divisions.

★

NEW RMA RESISTOR - CONDENSER COLOR-CODE WALL CHART

A completely new and timely compact color-code wall chart, which presents in both pictorial and convenient tabular form the complete RMA resistor and condenser color codes and also the different color code marking arrangements used by resistor and molded mica condenser manufacturers has just been issued in conjunction with the release of the new, completely revised and greatly enlarged 3rd Edition *Radio Troubleshooter's Handbook* by Alfred A. Ghirardi.

This chart is available free to radio service shops, manufacturers, schools giving courses in radio, and others in need of a useful reference on resistor and condenser color codes. It may be obtained free of charge by writing to Radio & Technical Publishing Co., 45 Astor Pl., New York, N. Y., enclosing a 3c stamp to cover postage.

★

Billie Burke presents Mrs. Florence Hillstead, inspector with Universal Microphone Co. with a $25. war bond. Mrs. Hillstead has a family of four, works 48 hours a week at Universal and one night a week with the Communications Corps of the Citizens Defense Corps, Los Angeles.

You are going to be a bigger man

Keep this fact clearly in mind: *electronics* is the growing art of harnessing electron tubes —in many cases, familiar types of radio tubes —to new applications; and it means everything to your future.

Big as the radio and communications industry has been, it is only *one phase* of electronics. Hitherto your opportunities have been practically limited to that one phase—transmission of sound. At the start of the war, television—transmission of sight—was just opening up.

When the war is over, television will arrive —but *it won't be alone.* RCA electron tubes will be put to work on thousands of *new jobs*—new electronic devices.

As a Tube and Equipment Distributor and Serviceman *YOU* will service these devices—sell replacement tubes they will require.

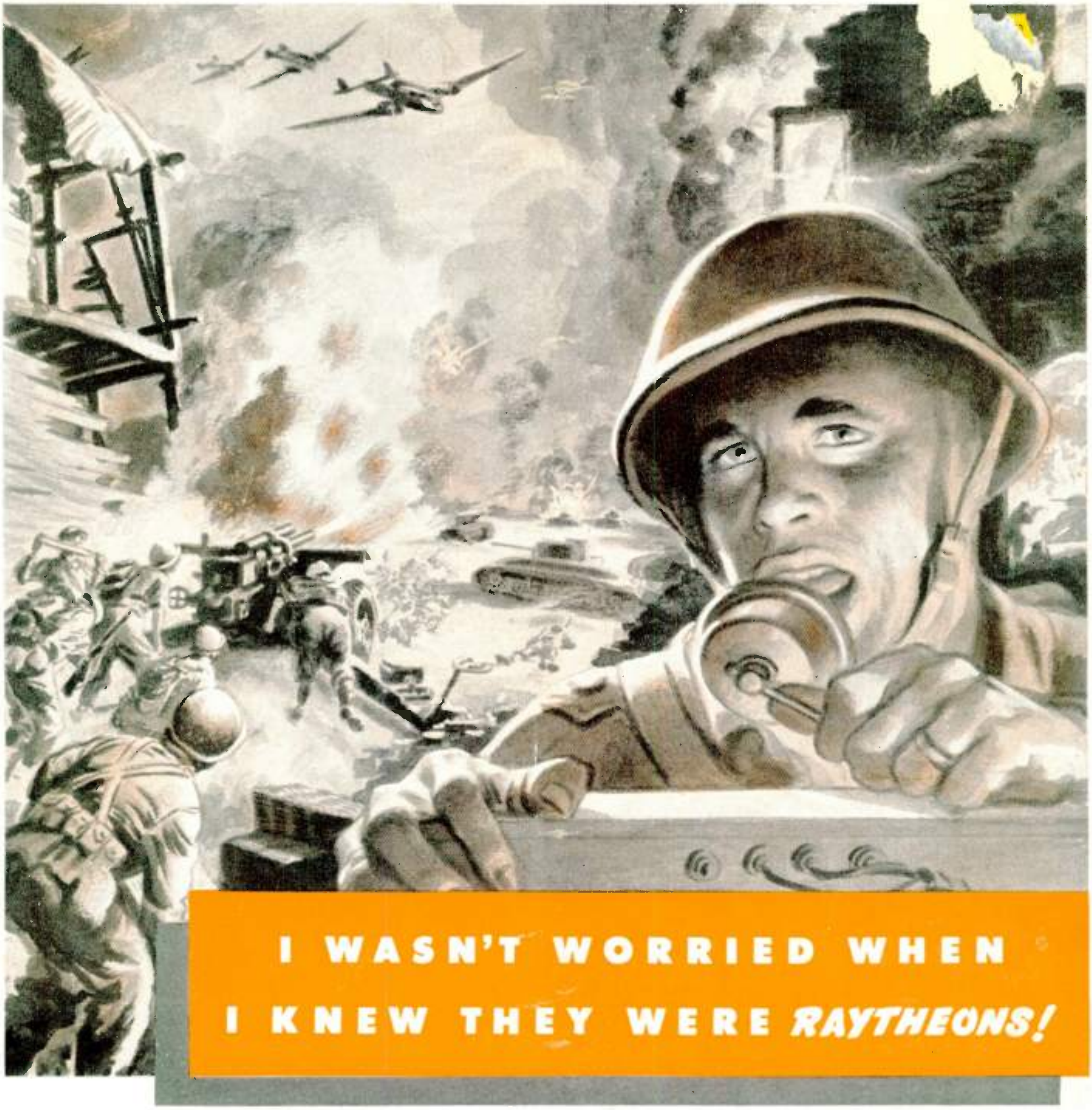
YOU will draw income from this vastly widened field. You will be a *bigger man*—expanding, reaching out, grasping opportunity. RCA Engineers and RCA Tube and Equipment Distributors and Servicemen, working together, can help enormously to make electronics the biggest industry, and the greatest public service, this country has ever known!

RCA

RCA ELECTRON TUBES

RCA Victor Division • Radio Corporation of America • Camden, N. J.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS



We were really in a tough position . . . if our messages did not get through I could not help but think of all the things that would happen to all of us.

Then I remembered the tubes used in my communications equipment were RAYTHEON tubes, because I had been a serviceman and knew tubes . . . knowing I had dependable RAYTHEONS backing up my messages gave me plenty of courage . . . I knew RAYTHEON tubes always gave me exceptionally good performance, even under unusual conditions . . . RAYTHEON quality never varied!

Today, thousands of RAYTHEON employees are tirelessly working to supply vitally needed tubes to our boys on all the fighting fronts!

Four "E" Awards

POWER TUBE Division · SMALL TUBE Division · EQUIPMENT Division · RADAR Division

ARMY NAVY

RAYTHEON PRODUCTION CORPORATION

NEWTON, MASS. · LOS ANGELES · NEW YORK · CHICAGO · ATLANTA

RAYTHEON TUBES RADIO & TRANSMITTING

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