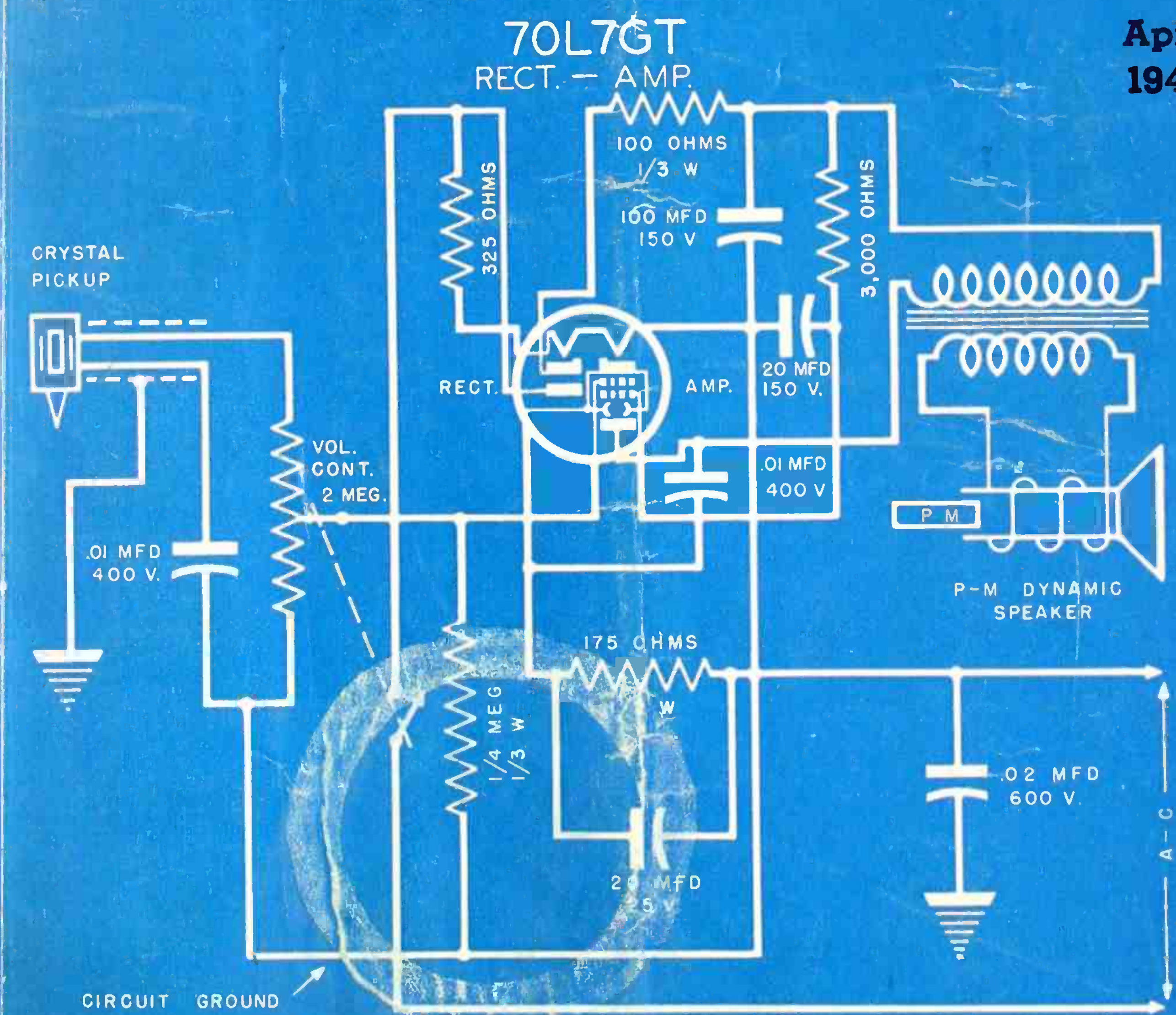
RADIO · TELEVISION · ELECTRONIC

SERVICE

April
1945



Record player with single dual-function 70L7GT serving as power rectifier and beam power output. (See page 42.)

A MONTHLY DIGEST OF RADIO AND ALLIED MAINTENANCE

What a Big Boy
HE'S GETTING TO BE
·the Radio Amateur Market

The radio amateur will attain new stature in the postwar years. Back from the war will come thousands of highly trained signal and communications veterans who will want to continue their forward progress in radio. These men will be looking for Hallicrafters equipment—the radio man's radio.

BUY A WAR BOND TODAY!

hallicrafters RADIO

THE HALLICRAFTERS CO., MANUFACTURERS OF RADIO AND ELECTRONIC EQUIPMENT, CHICAGO 16, U.S.A.

EDITORIAL

THE discussion of Service Men qualifications in the article *Hiring Service Men* in the February issue of SERVICE appeared to minimize the importance of selling ability, a requisite which should have been stressed, according to many comments received. Discussing this factor, one department store manager said that a successful Service Man must use a salesman's approach to repair problems. To service effectively, the Service Man must be able to discuss receivers and installation problems tactfully. The Service Man is a representative of the store, said this executive, and as such is actually responsible for sealing sales, present and future.

Wise words!

UNUSUAL data concerning causes of set failures and time spent on different types of repairs were disclosed in a survey recently completed by Sylvania. Analyzing the survey Frank Mansfield said that seven components were generally responsible for failures. These were, in their order of importance: tubes, condensers, power supplies, tuning systems, i-f coils, r-f coils and filters. Humidity was cited as the major cause of component failure. He reported that 40% of all repairs can be made either with tubes alone, or mechanical or electrical parts, or labor. Analyzing this further, he revealed that 52% of all repairs require tubes; 63% require electrical parts; 31% require mechanical parts; and 44% are pure labor problems.

DETAILED time records are now a *must* in Service shop practice, OPA has ruled. Hereafter you'll have to show time charges on all invoices, if you operate on an hour-charge basis. And your records will have to carry this information too. The nine regional offices of OPA have been given authority to study your books and act on any complaints. The ruling became effective March 19!

SOUND system interest increases daily. We have learned that an intensive project to promote the use of sound systems in schools is being planned by a special RMA school sound systems committee. The program will be conducted in cooperation with the U. S. Bureau of Education.

SERVICE

A Monthly Digest of Radio and Allied Maintenance

Reg. U. S. Patent Office

Vol. 14, No. 4 April, 194

Pag

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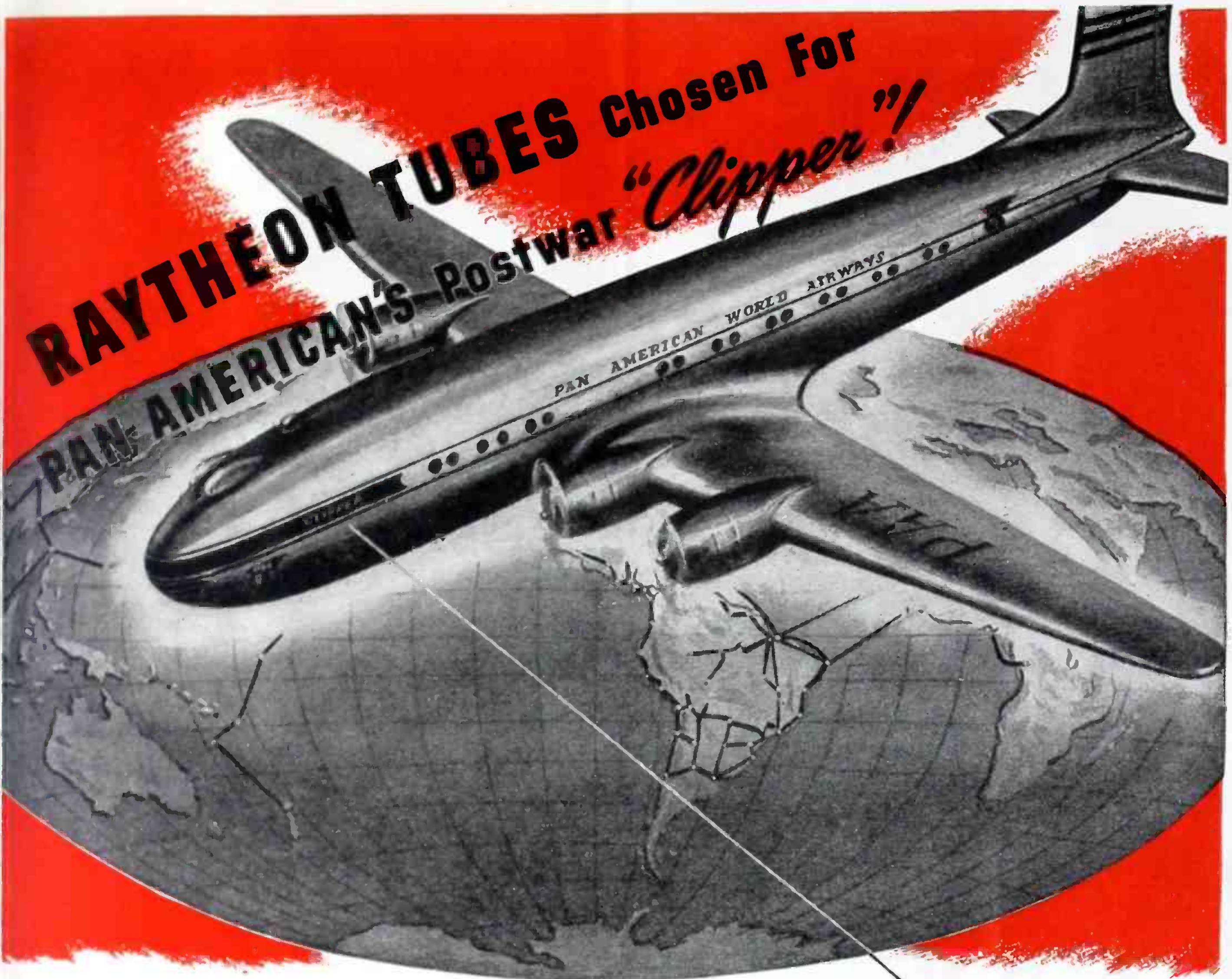

Feast your eyes on this mighty, 100-passenger airliner! When peace comes, a giant fleet of its sister ships will girdle the globe for Pan American World Airways. And in each of them will be the best electronic devices to come out of the war, equipped with famous Raytheon high-fidelity tubes!

Raytheon tubes have been used for years by Pan American, and it is because of their proven performance, fine reception and complete dependability that they were selected to play such a vital role in this great company's future operations. The assignment is but one of hundreds of postwar applications for which Raytheon tubes have been specified by America's radio and electronic industries.

When tubes are more readily available for civilian use, Raytheon will offer radio service dealers the *finest* tubes in its history . . . tubes combining long prewar experience with outstanding wartime development. And that's not all. They'll be backed by a Raytheon merchandising program that will be the most *beneficial* ever offered you. Keep your eye on Raytheon . . . for greater postwar profits!

Increased turnover and profits . . . easier stock control . . . better tubes at lower inventory cost . . . these are benefits which you may enjoy as a result of the Raytheon standardized tube program, which is part of our continued planning for the future.

Raytheon Manufacturing Company

RADIO RECEIVING TUBE DIVISION

Newton, Mass. • Los Angeles • New York • Chicago • Atlanta

Listen to "MEET YOUR NAVY" Every Saturday Night ENTIRE BLUE NETWORK Coast-to-Coast 181 Stations

RAYTHEON

High Fidelity

ELECTRONIC AND RADIO TUBES

All Four Divisions Have Been Awarded Army-Navy "E" With Stars

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


Centralab
CRL
Selector Switches
are available to servicemen and experimenters in kit form . . . or standard, completely assembled and individually cartoned.
Insulation . . . either steatite or bakelite.
All switches have double-wipe contact terminals for long life and have a consistently low contact resistance of less than 2½ milliohms and are completely self-cleaning. Index is positive with 30° between each rotating position.
Switches are also available for transmitter use.
Send for illustrated Catalog No. 24.
Centralab
CRL
Division of GLOBE-UNION INC., Milwaukee
Producers of VARIABLE RESISTORS — SELECTOR SWITCHES — CERAMIC CAPACITORS, FIXED AND VARIABLE — STEATITE INSULATORS — AND BUTTON-TYPE SILVER MICA CAPACITORS.

• The reproducer unit in this loud speaker was especially developed by JENSEN for use in the intercom systems in navy vessels. It reproduces speech clearly and sharply through high levels of noise. Ruggedly built, it withstands extreme shock and vibration, and is weatherproof against severe weather exposure conditions, dust and smoke . . . Like all JENSEN military models, this speaker is built around the most powerful permanent magnet material ever developed, ALNICO 5, as all JENSEN PM Speakers will be when conditions permit.

Now being introduced for the intercom systems on trains, and specifically designed for that purpose, this particular model has many possibilities for use wherever a heavy, rugged speaker with clear, sharp speech reproduction is needed. Write for complete engineering data on this speaker. Samples can be furnished on proper priority.

Jensen
SPEAKERS WITH ALNICO 5

Specialists in Design and Manufacture of Acoustic Equipment

JENSEN RADIO MANUFACTURING COMPANY, 6601 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

PREVIEW OF A STARTLING NEW FARM TYPE BATTERY

OLD

The present No. 748 1½-volt "A," 90-volt "B" A-B Pack
Dimensions, 15 13/16" x 6 15/16" x 4 15/32"
Weight, 23 lbs., 11 oz.

NEW

The New No. 758 1½-volt "A," 90-volt "B" A-B Pack
Dimensions, 10 11/16" x 6 13/16" x 4 1/8"
Weight, 16 lbs., 13 oz.

30% SMALLER, LIGHTER —BUT SAME CAPACITY!

THIS GIVES YOU an advance look at the latest "farm-type" radio battery to be developed by National Carbon Company. A revolutionary construction makes this smaller, lighter "Eveready" "Mini-Max" battery a reality. Actually it is a good 30% more compact than the present No. 748 A-B Pack. Yet not one bit of capacity has been sacrificed in achieving a valuable reduction in size and weight.

The advantages of this more compact battery will be obvious to you. The way is paved for smaller, less expensive battery-operated radio sets. And these sets will have the advantage of being far easier to move about from room to room. The way is likewise paved for sets of the present size utilizing the space saved by the new battery to use larger speakers giving improved receptivity and tonal qualities. Both add up to a greater demand for farm-type radios and an important increase in business for you.

This newcomer, known as the "Eveready" No. 758 A-B Pack, is only one of many improved types of "Eveready" batteries which will appear after the war. Look to National Carbon's exclusive construction, used in the "Mini-Max" battery, for more and equally important news to the trade.

"EVEREADY"

MINI-MAX

TRADE-MARK

RADIO "B" BATTERIES

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

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General Offices: NEW YORK, N. Y.

The trade-marks "Eveready" and "Mini-Max" distinguish products of National Carbon Company, Inc.

SPRAGUE TRADING POST

A FREE Buy-Exchange-Sell Service for Radio Men

REPLACING WET ELECTROLYTICS WITH DRYS

In many cases—particularly in old sets—you can use Sprague Atoms (midget drys) in available Victory Line types to replace unavailable wet electrolytic capacitors. Atoms stand the gaff! A few precautions should, of course, be observed, and these are described in the Sprague "Victory Line" Catalog C-304. Write for your copy today.

FOR SALE OR TRADE—5 years of Mechanix Illustrated. 1940 to 1945. Sell or trade for radio eqpt. Morton Bardfield, 4 Brinsley St., Dorchester 21, Mass.

WANTED—Hawaiian, Tahitian and South Sea phono records, must be new. Send list. Robt. J. Neu, 4359 N. 48th St., Milwaukee 9, Wisc.

WANTED—Late model tube tester, preferably Triplett, also speaker for model 70 Philco radio. A. W. Johnson, Wakefield, Nebr.

WANTED — Voltohmmeter, oscillograph, sig. generator, typewriter, etc. Have available 12SA7, 35Z5, and 50L6 tubes for trade only. Radio Repair Service, 9313 Olympic Blvd., Beverly Hills, Calif.

WANTED—Phono motors, any quantity—also 1-12-25-50-117 volt tubes, new and in sealed cartons. Leading Radio Service, 114 E. Third St., Mount Vernon, N. Y.

WILL BUY FOR CASH—1A7GT, 50L6, 35Z5, 45Z5, 117L or P7, 25Z5, 25Z6, 43, 80, 35Z3 tubes. Must be new, in sealed cartons. H. Stein, 456 Bedford Ave., Mt. Vernon, N. Y.

WANTED—AM-Tuner. Have 1 - 12" Jensen hi-fi PM speaker to trade. Paul Stieglitz, 4455 Broadway, New York 33, N. Y.

TO TRADE—Bliley 1000 kc Xtals, "AT" sub, frequency standard Xtals, in metal tube mounting, A-1 condition. Will swap one for 913 C.R.T., two for a 902 C.R.T., and three for a 906 C.R.T. Must be A-1. K. Kelly, RT 3/c, Apt. 307, 4940 So. Blackstone Ave., Chicago, Ill.

WANTED — Test eqpt., meters, etc.; Rider's manuals, complete or single vols., service manuals, etc. Describe fully. All letters answered. Cloverly Heights Radio Service, 1113 Hudson St., Harrisburg, Pa.

FOR SALE—Clough Brengle UE Unimeter M.A. 1, 10, 100 amp. 0 to 2 a-c volts or output 15, 150, 750 d-c volts 10, 100, 1000, 4 resistance ranges 1 to 2 megs., capacity to .1 mfd. $20. J. Schafer, 8 Alwyn Ter., Rutherford, N. J.

WANTED—Tube tester to handle most of tho latest tubes, also all-wave sig. generator, a-c or battery operated. Describe fully. Stoughton Sales & Service, 310 E. Main St., Stoughton, Wisc.

WANTED FOR CASH—Home recorder & record player or record player. Also want records. John Raposa Jr., 167 Washington St., Fall River, Mass.

FOR SALE—Astatic crystal pickups; phono motors; magnetic pickups; RCP 411 multitester; oscilloscope, meters, test eqpt., audio and power transformers, PA system, etc. Write for complete list. Lifetone Laboratories, 2013 Peoria Ave., Peoria, Ill.

FOR SALE—Bug key, excellent condition, $7.50. Cadet Cpl. Bob Butters, Missouri Military Academy, Mexico, Mo.

FOR SALE—Solar BQC 1-60 condenser tester, A-1 condition with instructions & test leads. Test all condensers. $15. Harry's Radio Service, East Setauket, L. I., N. Y.

FOR SALE—Radio tubes at OPA ceilings. Send for list. Crose Radio Service, 901 W. Touhy, Park Ridge, Ill.

FOR SALE—Latest model Meissner analyst, slightly used, $95. Bridgehampton Radio Shop, Bridgehampton, N. Y.

FOR SALE OR TRADE—One Dynamotor, type used in Majestic radio model 114; also 2 power transformers, pri. 115v a-c, sec. 600v a-c. Will trade for late tube tester, sig. generator, or V-O-M combination. W. Bredbenner, Jr., 232 E. 8th St., Berwick, Pa.

WANTED—SX-28 or SX-32 Hallicrafter comm. receiver with matched speaker. Would take SX-25. Cash. Sgt. Calvin White, Hq. Ba. 623 F.A., Obsn. Bn., Ft. Sill, Okla.

WANTED—Supreme 585 diagnometer, also 581 sig. generator. J. R. Morrison, 545 St. Paul's Pl., Bronx 56, New York, N. Y.

FOR SALE—Raytheon tubes: 3-1A6; 23-2A6; 4-2B7; 7-32; 4-33; 2-48; 4-52; 4-82 and 1-BR. T. Dempsey, 14497 Bringard Dr., Detroit 5, Mich.

WANTED—Good radio signal generator. Describe fully. Thomas C. Powell, 10812 Massie Ave., Cleveland 8, Ohio.

WANTED—0-200 milliammeter; any good multitester, also meter with a VTVM circuit designed to fit the meter. Leslie F. Hay, Snoqualmie, Wash.

WANTED — One 70L7GT tube. Chas. McClung, 45 Victor Ave., Highland Park 3, Mich.

WANTED—Philco 077 signal generator; also 027 vac. tube voltmeter & circuit tester. Must be A-1 condition. Wm. E. Ward, Box 204, R.F.D. #2, New Bedford, Mass.

FOR SALE—Complete radio shop with instruments. A bargain. Varela Radio Shop, 24 Barcelona St., Guayama, Puerto Rico.

URGENTLY NEEDED—One 0-1 milliammeter with or without universal scale. J. Farkas, 929 Inman St., Akron, Ohio.

WANTED—Hickok 155 traceometer; 510X set-tube tester; Precision 920P set-tube tester; Superior channel analyzer; complete set Riders. Have for sale Meissner FM adapter with 8 - 6v tubes, new. $35 postpaid. Soundways, 560 Walnut St., Fall River, Mass.

FOR SALE—Rider's "The Cathode Ray Tube at Work"—"Oscillator at Work"—"Frequency Modulation"—"Automatic Volume Control" and "Automatic Frequency Control Systems." All for $6. L. Hague, 2804 - 33rd Ave., Astoria, L. I., 2, N. Y.

FOR SALE—Weston battery operated sig. oscillator, #662; also Hoyt #100 tester, reads 0-10 d.c. milliamps; 0-6 and 0-24 volts d-c. Arthur Abrahamsen, 2633 Johnson St., N.E., Minneapolis 13, Minn.

WANTED — Hallicrafters SX24, S20R, S19R or Sky traveler for cash. Have 7-tube home made upright panel 80-160 meter CW or phone transmitter for trade or for cash sale. Write for details. Neat Radio Service, Box 26, Winchester, Ill.

TUBES FOR SALE at OPA list: 2-31; 7-37; 2-2B7; 2-6B8; 1-6C8; 1-6SR7; 1-6SL7; 1-6Z7; 2-7E7; 2-7H7; 1-7Q7; 1-7E6; 2-12B8; 5-7A4; 4-7A5; 2-12A5; 1-12SC7; 2-XXFM; 1-14J7; 1-14Y7; 2-14N7; 5-39/44 and 2-2051. Radio Service Lab., Box 314, Benkelman, Nebr.

FOR SALE—Two Jensen peri-dynamic speakers with PAH-8 driver unit, used but perfect, $25 each. Four Atlas metal baffles with Jensen PM 12c speaker units, used but perfect, $17.50 ea. with matching trans. Want portable record player. Ackerman Sound Service, Box 26, Storm Lake, Iowa.

WANTED—Hammarlund HQ-120X in good condition. Cash. Pvt. Jos. Zukanikas 33182926, c/o APO-94, c/o P.M., New York, N. Y.

WANTED—Rider's manuals vols. 6-8-12. State price & condition. Miller Radio Service, 927 W. Jackson St., Macmob, Ill.

FOR SALE OR TRADE—New AC-DC inverter, input 32v, output 110v, 100 watt capacity. Want good condenser tester, v.t. voltmeter, tubes, guns, or what have you. Seifert Motor & Impl. Co., Utica, Minn.

FOR SALE OR TRADE—Instructograph Jr. with tapes. Want phonographs, phono pickups, camera or what have you? Arlo Herrick, U.S.N. V-12 Unit, Little Campus, Austin 18, Texas.

WANTED—Echophone EC-1. Tom Vasko, 1163 Brentwood Road, Cleveland Hts. 21, Ohio.

WANTED—Radio parts, test eqpt. etc. Have Colt 38 special to trade. Earl R. Fry, 1311 E. 1th St., Winfield, Kans.

WANTED—Tube tester to handle modern tubes, in good condition, also good sig. generator. Cash. H. E. Moore, 13 S. Dubuque St., Iowa City, Iowa.

WANTED—Hallcrafter SX23, SX25 or similar. Will trade test eqpt., tubes, Rider manuals 1 to 10, also 11v AC 250-watt generator or pay cash. Evan W. Edwards, 57th & East Ave., Rt. No. 2, La Grange, Ill.

WILL TRADE hard-to-get tubes for good signal generator, preferably Superior 1230 or similar. Milton Kalashian, 2 Congress St., Newburyport, Mass.

URGENTLY NEEDED—a precision 832-A; Radio City 446-A or similar AC-DC V-O-M. Have AA3-V3 and AA5-MRO priority. Cash and critical tubes. Also want Knight 7-watt 3-tube amplifier No. 93-010 with or without tubes, etc. Cash. Ronald K. Brokloff, 188 Blaine St., Johnstown, Penna.

FOR SALE—Several hundred new surplus tubes, battery types, 6v, 12v, 14v, 7v, some rectifiers, etc. What do you need? Bennett Radio & Elec. Co., 4273 W. Easton Ave., St. Louis 13, Mo.

FOR SALE—Transmitter parts for 60-watt rig including crystals and power supply tubes, etc.; also have radio parts, and receiving tubes. Bou Radio Repairs, 3131 N. Perry St., Philadelphia, Pa.

WANTED—Someone to build all 110 v. a-c 2- or 3-tube plug-in coil receiver to receive std. broadcast and 317 k.c. Doesn't need much range, to use magnetic speaker or phones. To be used in crash station at air base. Refrigerator Repair Service, Kinsley, Kans.

FOR SALE—Fulton 7 in. television receiver; also facsimile receiver. Both complete, ready to operate. M. Ballowitz, 3031 Brighton 14th St., Brooklyn, N. Y.

WANTED—Will pay good price for copy of setting chart for Radio-tech. tube checker model 0. Will copy and make extras for you. Have chart for latest tubes, but need chart for older ones. Carl Fishback, Rt. No. 1, Box 15, Hillsboro, Ore.

FOR SALE—RCA Radiola No. 18, table model. 7-tube std. broadcast receiver with 8 in. speaker in metal cabinet. A-1 condition. $20 cash. Herman Fischer, 626 Carlton Ave., Brooklyn 17, N. Y.

WANTED—Test and servicing equipment. What have you? K. W. Guldin, 2530 Cleveland Ave., West Lawn, Pa.

FOR SALE—Jewel 3½ in. round panel type meter, has 0-8 volt scale. Perfect condition, $7. J. Goldstein, 151-09 34th Ave., Flushing, L. I., N. Y.

SEND US YOUR OWN AD TODAY!

For almost three years now, the Sprague Trading Post has been helping radio men get the materials they need or dispose of radio materials they do not need. Literally thousands of transactions have been made through this service. Hundreds of servicemen have expressed their sincere appreciation of the help thus rendered.

Send your own ad to us today. Write PLAINLY — hold it to 40 words or less — confine it to radio materials. If acceptable, we'll gladly run it FREE OF CHARGE in the first available issue of one of the five radio magazines wherein the Trading Post appears every month.

HARRY KALKER, Sales Manager.

Dept. S-45, SPRAGUE PRODUCTS CO., North Adams, Mass.

Jobbing Distributing Organization of Products of the Sprague Electric Co.

SPRAGUE CONDENSERS KOOLOHM RESISTORS

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Fine instruments produced in volume with precision first . . . to last.

Triplett

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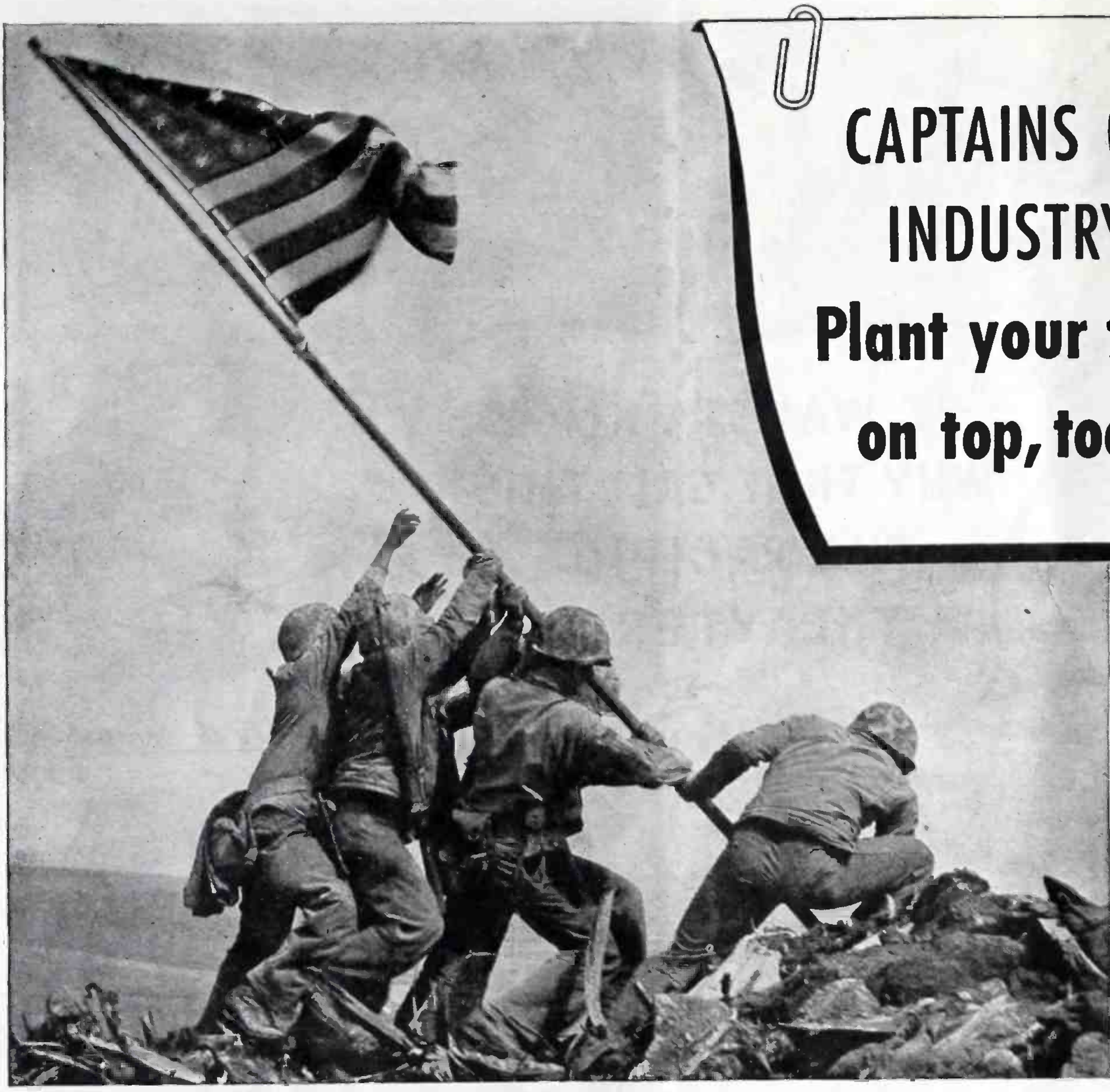
ELECTRICAL INSTRUMENT CO.
BLUFFTON, OHIO



CAPTAINS OF INDUSTRY Plant your flag on top, too!

This year we've got to make 2=3!

This year we've got to make 2=3! We've got to lend Uncle Sam in 2 chunks almost as much as we lent last year in 3. Which means that, in the approaching 7th War Loan, each of us is expected to buy a BIGGER share of extra bonds.

The 27 million smart Americans on the Payroll Savings Plan are getting a headstart! Starting right now they are boosting their allotments for April, May and June—so that they can buy *more* bonds, and spread their buying over *more* pay checks.

Our Marines went over-the-top at Iwo Jima in the greatest, and hardest, battle in the Corps' history. Now it's *your* turn! Your quota in the 7th is needed to help finish this war, side-track inflation, build prosperity. So, captains of industry, plant your flag on top—like the Marines at Iwo Jima!

★

CAPTAINS of INDUSTRY—here's your *Check List* for a successful plant drive:

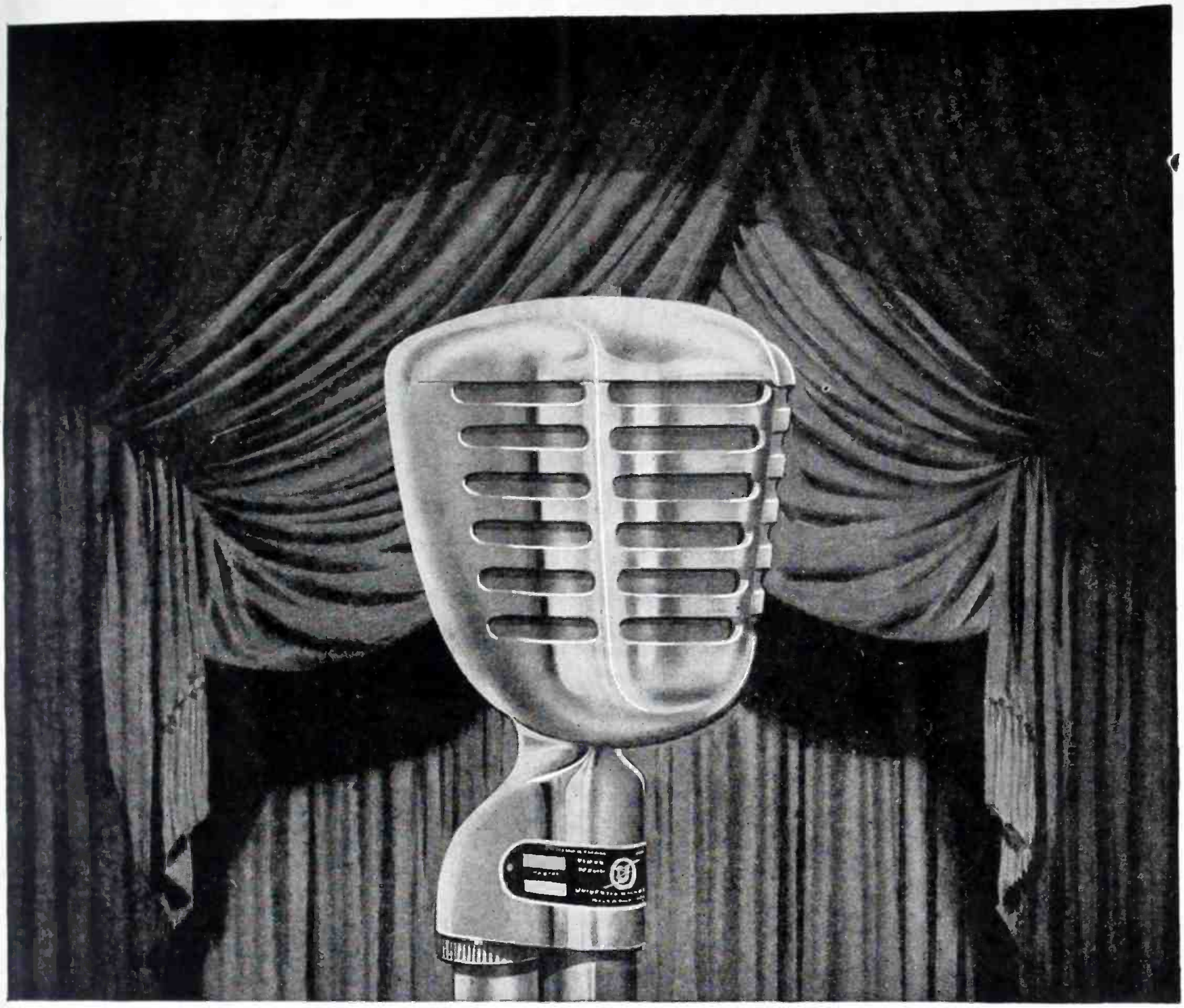
- ★ Get your copy of the "7th War Loan Company Quotas" from your local War Finance Chairman. Study it!
- ★ Determine *your* quota in E Bonds — the backbone of every War Loan.
- ★ Arrange for plant-wide showings of "Mr. & Mrs. America"—the new Treasury film.
- ★ Distribute "How to Get There"—a new War Finance Division booklet explaining the benefits of War Bonds.
- ★ Circulate envelopes for keeping bonds safe.
- ★ Display 7th War Loan posters at strategic points.
- ★ And—see that a bench-to-bench, office-to-office 7th War Loan canvass is made.

★

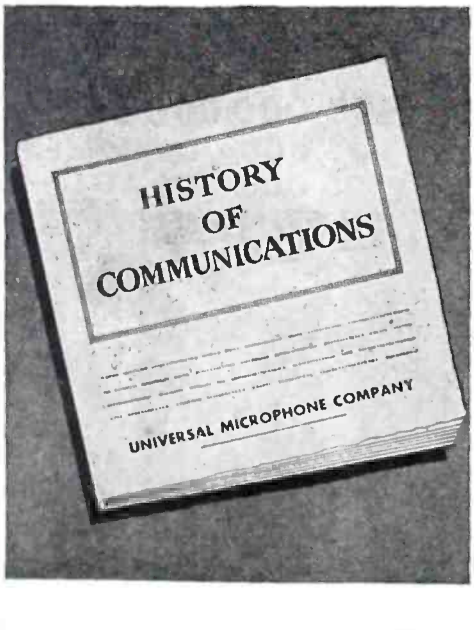
The Treasury Department acknowledges with appreciation the publication of this message by

SERVICE

★ *This is an official U. S. Treasury advertisement prepared under the auspices of Treasury Department and War Advertising Council* ★



UNIVERSAL'S NEW D-20 MICROPHONE



The stage was set for something new and here it is. Universal's new D-20 Microphone . . . soon on your radio parts jobbers' shelves to fill your essential requirements . . . uses Universal's "Dynoid" construction . . . A dynamic microphone of conventional characteristics built to fill the utility requirements of war time plus advance styling of the many modern things to come. Orders placed now with your Radio Parts Jobbers will assure early delivery when priority regulations are relaxed.

Write for Bulletin 1458 covering this new microphone.

< FREE – History of Communications Picture Portfolio. Contains over a dozen 11" x 14" pictures suitable for office, den or hobby room. Write factory for your Portfolio today.

UNIVERSAL MICROPHONE COMPANY

INGLEWOOD, CALIFORNIA

FOREIGN DIVISION: 301 CLAY STREET, SAN FRANCISCO 11, CALIFORNIA ·· CANADIAN DIVISION: 560 KING STREET WEST, TORONTO 1, ONTARIO, CANADA

SYLVANIA NEWS
RADIO SERVICE EDITION

APRIL *Published by SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa.* 1945

As another aid to servicemen, Sylvania offers its "Business Record for Income Tax Purposes" book—a simple, exact system of record keeping. (Many servicemen have been using this handy book for at least two years. Many probably wish they had.)

Two pages describe the best way to use your business record book.

Send for "Business Record for Income Tax Purposes" now—it can be started at once and will save time, expense and worry in the months to come. Your Sylvania distributor will be glad to show you a sample copy. Nominally priced at $1.00, your copy can be had immediately.

Sylvania's Survey Report Shows Postwar Need for More Servicemen

Thousands More Repair Shops and Men Required for Big Job Ahead

Once again Sylvania's nation-wide, independent radio survey—conducted by one of America's leading research organizations—reports facts and trends valuable to the radio serviceman. This is the second of a series of survey reports designed to aid servicemen in their present and postwar planning.

There are 60 million radio sets in use throughout America today. Sylvania's survey shows that as close as five to six years after the end of the war this number will increase to no fewer than 75 million home radio sets, plus a total of 25 million automobile radios. All of these millions of units are expected to be more complex in construction and will require more of the expert service radio repair men have been rendering.

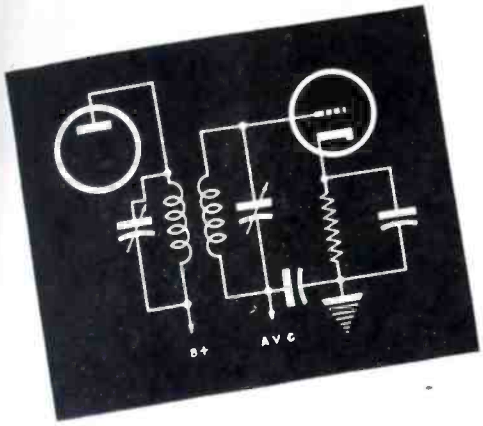
Our survey reveals that present-day repair shops are well equipped, but servicemen fully recognize the postwa need for more and better instruments-more and better training—essential to th big task of servicing millions of phono-console combinations, F. M., and televi-sion sets.

In keeping with this recognized need, Sylvania Electric has developed a whole kit of bulletins and technical literature to aid servicemen with their problems.

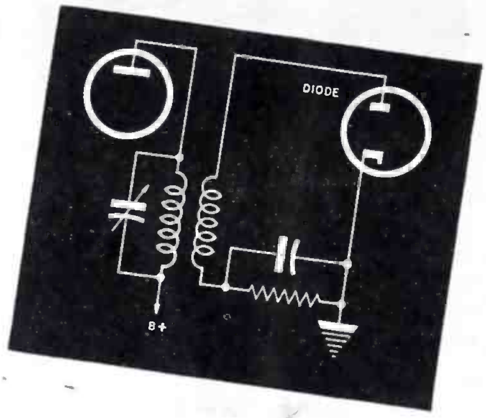
SYLVANIA ELECTRIC

MAKERS OF RADIO TUBES; CATHODE RAY TUBES; ELECTRONIC DEVICES; FLUORESCENT LAMPS, FIXTURES, ACCESSORIES; INCANDESCENT LAMPS

SERVICE
A Monthly Digest of Radio and Allied Maintenance



Figs. 1 (left) and 2 (right). In Fig. 1, we have a typical double-tuned i-f transformer arrangement, a feature of most receivers. Compression type capacitors having a range of from 50 to 250 mmfd are ordinarily used. Fig. 2 illustrates a single-tuned i-f unit system used in less expensive receivers.



I-F AMPLIFIERS

DESIGN ... APPLICATIONS ... SERVICING

by ROBERT L. MARTIN

INTERMEDIATE-FREQUENCY amplifiers are essentially tuned r-f amplifiers operated in class *A*. As the principal gain and selectivity elements of superheterodyne receivers, these amplifiers command close attention.

Intermediate Frequency Choice

In designing a receiver, the choice of the intermediate frequency is governed by several factors, the principal ones being:

(*1*)—Selectivity; generally speaking, the lower the frequency the better the selectivity.

(*2*)—Image rejection; the higher the frequency the more spread between signal and image (higher frequencies preferred).

(*3*)—Gain; lower frequencies permit higher gain but this is less important than the foregoing considerations. New tubes have high gain at high i-f.

(*4*)—Pass band; especially for f-m, television and special similar services. A high i-f makes it easier to obtain widepass bands.

(*5*)—Crystal filters for super selectivity, single c-w band reception, etc.

Tube Problems

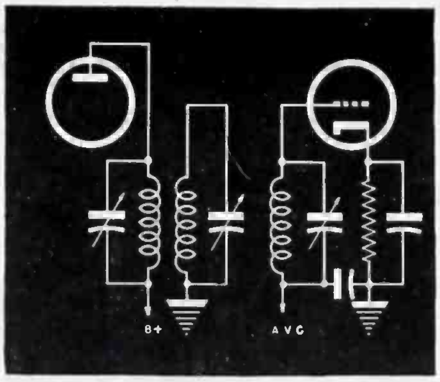
Probably the next most important consideration is the choice of tubes. Pentodes are, of course, the most logical i-f amplifier tubes since they have negligible grid-plate capacity for maximum stability, high plate resistance for minimum loading of the tuned circuits, high mu and high transconductance for high gain. The figure of merit for this type of amplifier tube is approximately proportional to $\frac{\mu^2}{R_p}$ where μ is the amplification constant and R_p the plate resistance. Also, variable μ, or remote cut-off types, are preferred to sharp cut-off types to prevent cross modulation when the volume control is set for low sensitivity and to permit a wide range of avc action.

Frequency Ranges

The first American supers had fixed-tune i-f transformers operating at about 15 kc. These units were called catacombs. Low-gain battery-operated triodes were used. Present standard i-f transformers are double-tuned with trimmer-type compression capacitors having a range of 50 to 250 mmfd, Fig. 1. The usual i-f is approximately 455 kc although 262, 175 and 130 have also been used. If the capacity was to be reduced much below 40 mmfd, changing tubes might cause misalignment. The two coils used in this type transformer are usually wound with seven or ten strands of Litz wire but, in the less expensive receivers, a small solid wire is used. The latter has a lower *Q* with a consequent lower gain. The coils are spaced for optimum coupling or just close enough so that a double peak does not appear, but band-pass operation is attained. This produces a broad-topped resonance curve which is near enough to a rectangular band-pass characteristic in performance to satisfy most requirements. Ideally, a steep-sided characteristic will give great selectivity while a wide-pass band, wide enough to handle the highest audio frequency it is expected to reproduce, will permit a high-fidelity wide-frequency range. The main factors governing bandwidth are coupling and effective resistances.

Shielding

I-f transformers are usually placed in a shielded can made of aluminum, zinc, copper, or even iron. Since iron cans cause high losses they are often lined with copper foil. Fig. 2 shows a single tuned i-f transformer which is often used in the less expensive receivers to feed the second detector. When 175 kc is used for the i-f this



type of transformer has sufficient selectivity for automobile receivers or sets using a 3-gang condenser with a t-r-f stage. In the latter case the t-r-f stage contributes substantially to the overall selectivity.

Tripled-Tuned I-F

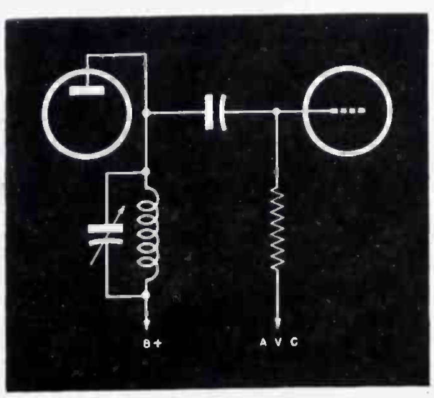
Fig. 3 shows a triple-tuned transformer, a more expensive item, but one closely approximately flat-topped performance giving good bandwidth for high quality a-m receivers. The three trimmers are stagger tuned, each to a slightly different frequency, for the widest pass band. Some designs have a variable selectivity feature obtained by altering the tuning of one element.

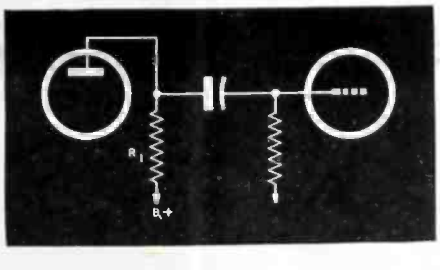
Iron Core I-F

In Fig. 4 we have a circuit using an i-f transformer employing finely divided iron as a core material for permeability tuning which eliminates the need for trimmers. This type of unit, although more expensive than the type of Fig. 1, has far better gain, making it particularly useful in small portables and expensive receivers. The stability is much better than compression type trimmer transformers. Also, they are more easily adjusted than compression-type elements. The Q of iron-core units is 2 to 2.5 times that of standard air-core units.

Resistance Coupling

Some receivers use a resistance-coupled i-f stage which is usually





Figs. 3 (left), 4 (right) and 5 (above)

Fig. 3 illustrates a triple-tuned i-f system used in high-quality a-m receivers. Fig. 4 shows an iron-cored i-f system, which eliminates the need for trimmers. In Fig. 5 we have a resistance-coupled i-f usually placed between a dual-tuned first i-f transformer and a dual-tuned unit feeding a second detector.

placed between a dual-tuned first i-f transformer and a dual-tuned unit feeding the second detector, Fig. 5. This type of coupling contributes nothing to the selectivity but has a gain of about 20. It is useful in battery sets, farm sets or receivers not subject to large signal inputs which might cause image interference.

Tuned Plate System

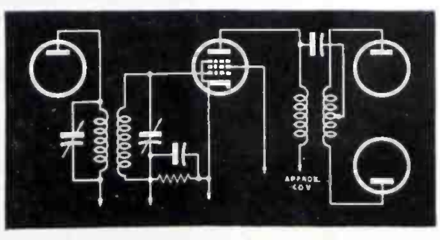
A compromise system of coupling is that of Fig. 6 which has a tuned-plate circuit resistance coupled to the following grid. It has more gain than the former system and also some selectivity but its uses are restricted much the same as the straight resistance-coupled stage.

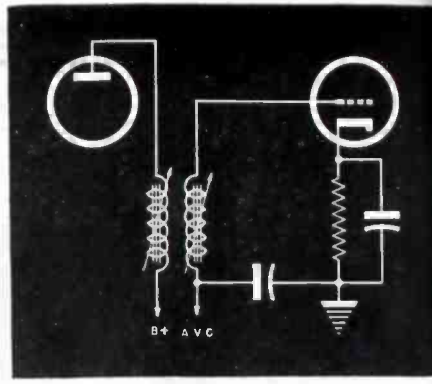
Alignment

Aligning an a-m i-f stage without regard to bandwidth is simple. A signal at the proper i-f is fed to the last i-f grid and the two trimmers are adjusted for maximum signal or avc voltage. The same tuning is followed stage by stage until the signal is fed to the converter grid. Then a final recheck is made. If oscillation occurs, the first i-f may be slightly detuned

Figs. 6 (left), 7 (right) and 8 (below)

Fig. 6 illustrates a compromise i-f system using a tuned-plate circuit resistance-coupled to following grid. In Fig. 7 we have the popular type of combined a-m/f-m transformer where L_1 and L_2 represent the f-m unit operating on 4.3 mc, and L_3 and L_4 constitute the standard band i-f unit. Fig. 8 shows a limiter type transformer setup.





provided the overall gain is still adequate.

F-M Receivers

The f-m receiver uses wide-band i-f amplifiers up to a few hundred kc centered around a mean frequency of 3 to 8½ mc. Many combination a-m/f-m broadcast sets use 4.3 mc. Fig. 7 shows a popular type of combined a-m/f-m transformer used in some of these receivers. L_1 and L_2 constitute the f-m transformer operating at 4.3 mc while L_3 and L_4 make up the standard a-m type of unit. The loading effects of the f-m coils are included in the peaking of the a-m tuning at 455 kc. The a-m trimmers C_1 and C_2 act as effective bypass condensers for the f-m circuit. Thus there is a minimum of loss in this combined unit.

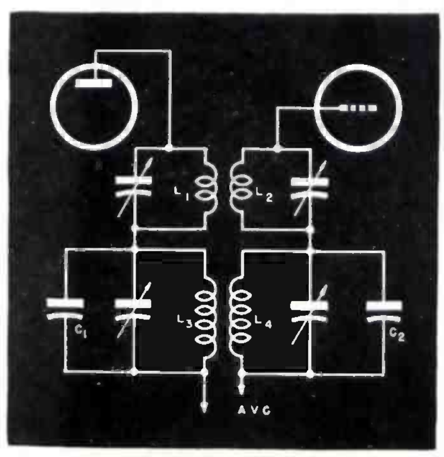
F-M Limiter Transformer

Fig. 8 shows a limiter-type transformer, usually similar to a standard dual-tuned unit, but with a high resistance placed in the grid circuit. The limiter stage operates at a low plate voltage, approximately 60 volts, limiting the a-m peak output by plate current saturation.

Television I-F

The i-f units used in television receivers are the most difficult to design. They must pass an extremely wide band of many mc (4 mc in the present system) and, at the same time, deliver

(*Continued on page* 30)



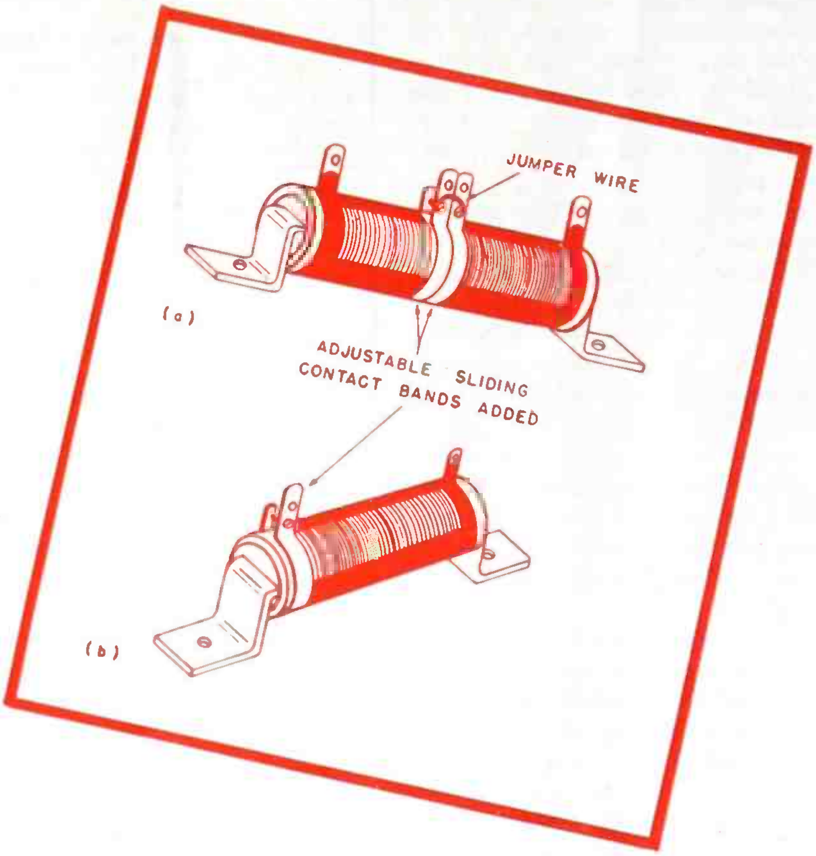


Fig. 1. Methods of repairing resistance wire (*a*), or imperfect contact at terminals (*b*), of vitreous-enameled type wire-wound resistors.

FIXED RESISTORS
TROUBLES AND SERVICE HINTS

[*Part Two of a Series*]

by ALFRED A. GHIRARDI

Advisory Editor

A DIFFICULTY frequently experienced with uninsulated composition resistors is that their resistance value changes due to climatic conditions, or as a result of being operated in an overloaded condition, or being mounted too close to some other very hot component in a receiver.

Uninsulated molded-carbon resistors are inherently porous and so have a tendency to absorb moisture. Consequently, in moist tropical regions, or in temperate zones during the summer months when the temperature and humidity run high, the resistance values may change upsetting the operation of the receiver. Most manufacturers now coat them with a lacquer or enamel that forms a protective coating to reduce this action. The *insulated* type of composition resistor is protected against such trouble by the almost perfect moisture-proof phenolic enclosure which surrounds the resistance element. Thus most Service Men prefer it for replacement purposes.

Overheating and Noisy Composition Resistors

Composition resistors will also change in value or become *noisy* as a result of being overloaded or being excessively heated by nearby heat-generating components such as rectifier tubes, line-dropping resistors, etc. This causes them to operate at temperatures higher than their design permits. Continued overheating seems to cause partial disintegration of the resistor material. This is accompanied by slight variations in contact resistance (or by small arcs) between its granular particles. These, of course, cause fluctuations in the current flow, which, in turn, cause fluctuations in the voltage drop across the resistor. Such fluctuations in current flow or voltage drop are amplified by the succeeding amplifier stages and are reproduced in the loudspeaker as noise. (Hence, this trouble is especially important where high-gain amplifiers are employed.) If the fluctuations are rapid, they appear as a *scratchy* noise, while if they are of a more intermittent nature they will be heard as a series of *clicks*. Some of the particles may also fuse and melt together and thus cause a permanent change in the total resistance value and characteristics. Noise also may be caused by poor or intermittent contact that the excessive heating has developed between the body of the resistor and the terminal wires or caps.

The fact that carbon resistors have

a *negative* temperature coefficient of resistance often accelerates this destructive action when such resistors are used in circuits in which the amount of current flowing is determined mainly by only their own resistance value. As the resistor heats up, its resistance *decreases*. This causes a cumulative effect! As it gets hotter, its resistance value decreases further, so it draws more current; this makes it still hotter (since power dissipated, $W = I^2 R$); this causes the resistance to decrease further, allowing more current to flow . . . , etc.

A noisy composition resistor can generally (though not always) be detected by a scorched external appearance caused by overheating. Also, such a noisy resistor can often be located by tapping the various composition resistors in the receiver lightly with a pencil. This must be done while the set is turned on and after the resistors have reached their regular (hot) operating temperature, for faults that show up while the resistors are hot may not reveal themselves when they are cold. Special test units similar to those used by the resistor manufacturers can be assembled for determining whether or not a resistor is noisy, but the cost of such a tester is usually more than is warranted by the low cost of a replacement resistor. Substituting a new resistor of proper value in place of any unit suspected of being noisy will quickly tell whether the suspected unit is noisy or not.

When a case of a noisy, or otherwise faulty, composition resistor comes to hand and it appears that it deteriorated from overheating, a visual checkup of all the nearby components should be made before replacing the resistor. This is to ascertain whether any power resistors, rectifier or power tubes, or other components generating appreciable heat are located too close to it. If so, the replacement resistor should be re-located further away from such components, or the parts should be re-located further away—whichever is most practicable. To illustrate: a 10-watt wire-wound power resistor will develop its full allowable rated temperature of 275° C (over 550° F) if it is dissipating a full 10 watts of electrical energy and is in free air at 40° C. Such high temperature can quickly injure a composition resistor mounted very close to the power resistor, for composition resistors can safely withstand only about 110° C without damage.

If a composition resistor has deteriorated due to overheating caused by electrical overload, it should always be replaced with a resistor of the next higher available wattage rating.

Preferred Resistance (ohms)	Available in These Tolerances: ±5% (Gold Band)	±10% (Silver Band)	±20% No color
10	*	*	*
11	*		
12	*	*	
13	*		
15	*	*	*
16	*		
18	*	*	
20	*		
22	*	*	*
24	*		
27	*	*	
30	*		
33	*	*	*
36	*		
39	*	*	
43	*		
47	*	*	*
51	*		
56	*	*	
62	*		
68	*	*	*
75	*		
82	*	*	
91	*		

Fig. 2

RMA Standard Preferred Values of Fixed Composition Resistors

Over the range from 10 ohms to 10 megohms, the resistor values, listed in the left-hand column, and these values multiplied by any multiple of 10, are the *RMA Preferred Resistor Values*.

Tolerance: The tolerances in which each *Preferred Value* resistor are available are indicated by the asterisks.

Example: 1600 ohms is available in ±5% tolerance only; but 270,000 ohms is available in ±5% or ±10% tolerance. Likewise, 4.7 megohms is available in ±5%, ±10%, or ±20% tolerance . . ., etc.

Shorts or Grounds

Internal shorts or grounds, of course, are impossible within a composition resistor, but it is entirely possible for the body of an unenclosed type molded-carbon resistor to become externally shorted or grounded to an adjacent component, or wiring, or the receiver chassis. Careful visual inspection will usually spot such a condition, and it is easily rectified.

It is entirely possible for the leads of either unenclosed or insulated types of composition resistors to touch each other, adjacent wiring or components, or the chassis of the receiver, thereby causing shorts or grounds. Sometimes visual inspection alone will reveal such conditions. In other cases, ohmmeter tests are necessary. In either case, the condition may be easily rectified.

Open Resistors

Composition resistors may develop an intermittently *open*, or completely *open* condition, usually due to a loosened joint at the points where the two wire leads make contact with the resistance material. If a resistor of any type is suspected of being *open* (unless a check of the schematic circuit diagram definitely shows it to be not shunted by any other resistor, coil, capacitor, etc.) one end of it first should be disconnected from the circuit in which it is connected. Then the resistance of the resistor should be checked with an ohmmeter. We disconnect the resistor while testing to remove the possibility of some other resistor or component being connected to its circuit and acting as a shunt path, causing a false resistance indication to be obtained on the ohmmeter. In the case of an intermittently open composition resistor its wire leads should be pulled and pushed while the ohmmeter test is being made, in order to reveal the trouble.

Resistors which crack or break in any way can usually be spotted visually.

Measuring Suspected Resistors

We must remember that composition resistors have a *lower* resistance when warm than when cold. The resistance of a typical commercial resistor of this type may decrease as much as 6% as the resistor warms up from ordinary room temperature to normal operating temperature. (The normal temperature rise varies with the size and manufacturer.) Therefore, when the resistance of suspected resistors is being checked, the receiver should be left in operation for a while so that all of its components will heat up to normal operating temperature. Then the resistors should be checked while they are warm. Remember, however, that composition resistors are usually used at points where considerable variation in resistance value is tolerable, or where the resistor is operated well under its wattage. If we refer to the tabulated data of Fig. 1*b* (March, SERVICE) we note that variations as great as ±20% from stated resistance value are entirely permissible in the case of most of the composition resistors employed in household receivers.

Soldering Composition Resistors

When soldering the leads of composition resistors into the receiver circuits, we must be careful not to hold the soldering iron too long on the joint for this will overheat the resistance element and change its resistance. We must use a clean, well-tinned hot iron that will make the joint quickly. Composition resistors of the smaller sizes,

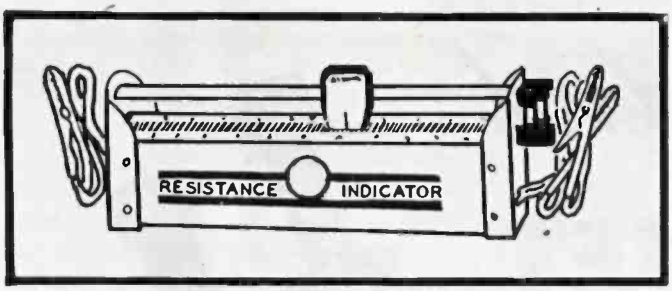


Fig. 3. A handy fuse-protected calibrated resistor for substitution purposes in determining resistance of charred, unmarked, etc., resistors. Range is 100 to 100,000 ohms.

especially when their leads are clipped short, are most liable to damage from this cause, for the resistance element being small is more easily and quickly heated and is nearer the part being soldered.

Cost Factors

As the cost of composition resistors is relatively low, when any doubt exists as to the fitness of such a unit, it should be replaced with a new one, for time and reliability of repairs are worth a great deal more than the trivial cost of the new unit. Since the insulated types cost but a trifle more than the uninsulated types, their many practical advantages make them preferable.

RMA Standard Preferred Values

The fixed composition resistors employed in home and automobile radios are almost invariably of the so-called *Preferred Number* or *RMA* standard resistance values. These values, tabulated in Fig. 2, have been selected and standardized by RMA because the entire range of resistor values commonly employed in such receivers can be conveniently covered in each of the common 5%, 10% and 20% tolerance groups by means of the comparatively small number of resistors listed, thus reducing the total number of composition resistor sizes required for initial supply and replacement in service work. These are the sizes most commonly stocked by parts jobbers and hence are those most readily available to the Service Man.

The *Standardized Preferred Resistance* values over the range from 10 ohms to 10 megohms are presented in the condensed table for convenient reference.

Determining Proper Values for Replacement

When replacing a faulty fixed resistor it is important to make certain that the replacement unit is within the resistance tolerance value allowable for the particular circuit function for which it is used, as well as correct in wattage-dissipation capacity.

The matter of determining the correct resistance value and wattage rating for the replacement unit is one that often requires intelligent consideration of the particular circuit conditions involved. The Service Man can expect to run into any of the following situations:

(*1*)—Resistance color code on faulty resistor is distinguishable and indicates a resistor of *RMA Preferred Value*, but no wattage rating is marked.

(*2*)—The same situation as in (*1*), but color code indicates a resistance that is not an exact *RMA Preferred Resistor value*.

(*3*)—Resistance color code is not marked or is not distinguishable; no wattage rating is marked.

In case (*1*), there are three alternatives:

(*a*)—The correct wattage rating of the resistor may be secured from either the schematic circuit diagram or the parts list of the receiver in the proper service manual.*

(*b*)—If the receiver is an *orphan* or *brand* receiver not listed in the service manuals, it may be possible to identify the wattage rating of the faulty resistor by noting its dimensions. Experienced Service Men can tell at a glance whether a composition resistor is a ½, 1, or 2-watt unit merely by noting its size. Of course there is some variation in physical dimensions among resistors of various manufacturers, but this usually is not so great that the power rating cannot be identified visually in this way. At any rate, the wattage rating may be guessed at in this way, or a unit of proper resistance value and same physical dimensions as the faulty unit may be selected and installed in the receiver. Then its temperature may be checked by feeling the resistor after the receiver has been operating for about ½ hour. If the resistor gets too hot, a unit of similar resistance but higher wattage rating should be used instead.

(*c*)—The foregoing problem may also be solved quickly in many instances by tracing the wiring leading away from the two terminals of the faulty resistor and determining in this way just what is its position or function in the circuit. For example, by tracing the leads it may be found that the resistor is used as the grid bias unit, or the plate load, etc., for some particular tube in the circuit. Reference to a tube chart will then show what the normal current should be in that particular circuit of this tube type, or what the voltage drop across this resistor should be, etc. Then either the formula I^2R, E^2/R or IE may be applied to determine the power dissipated in the resistor. The general practice among Service Men is to use a replacement resistor having a wattage rating at least *double* the average wattage dissipation expected, or such as the use of a 1-watt resistor for an element that must dissipate ½ watt, etc. Common sense should be a guide in this respect. The ambient (surrounding) temperature and the particular position of the resistor are important factors in the choice of resistor power rating. A resistor should seldom be operated at its full rating, even if it is in the clear away from any obstruction to good ventilation. Some safety factor should always be allowed. Where parts are jammed together in compact receivers, or where the resistor is to be mounted near a hot power resistor, rectifier tube, etc., allow 3:1.

In case (*2*), and in general whenever it is not convenient or possible to obtain a replacement resistor of exactly the same resistance value as that of the faulty unit (or as that indicated by a *calculation* for the required resistance

(*Continued on page* 32)

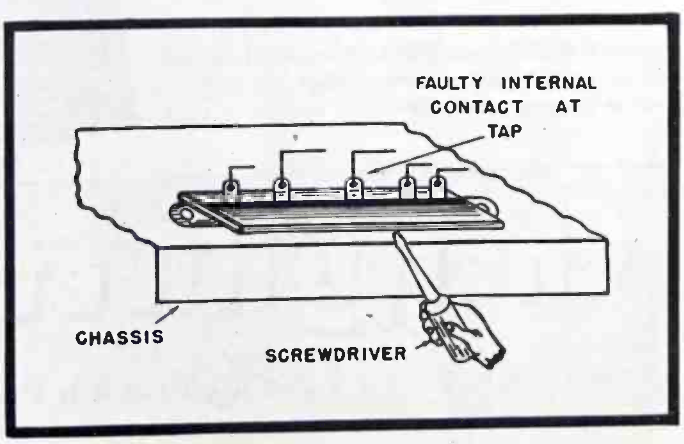


Fig. 4. Repairing faulty internal contact at tap of a metal-clad resistor.

*When referring to service manuals always make certain that all the publisher's corrections and all changes or additions to originally listed data made necessary by subsequent receiver manufacturer's changes in various production runs of the particular receiver model in question have been made in the manual. Otherwise incorrect and misleading data regarding the circuits and components may be followed.

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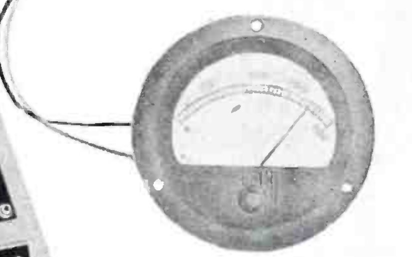

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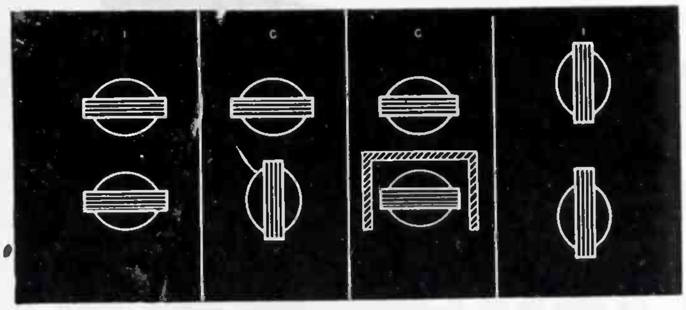
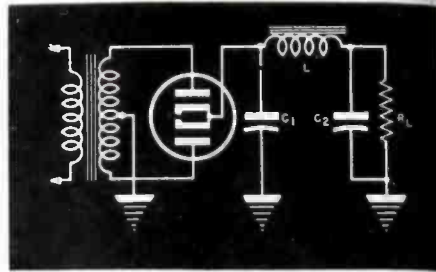


Figs. 1 (left) and 2 (right). Fig. 1 illustrates the incorrect and correct methods of mounting transformers to prevent hum. The two outside positions are incorrect; center two, correct. Fig. 2 shows a standard *B* supply and filter network.



HUM . . . ITS CAUSES

by EDWARD ARTHUR

HUM, in receivers, may be caused by any circuit carrying a-c or its components. Thus, tube filaments, filament wiring, power transformers, filter condensers and filter chokes, are possible sources of hum potential.

Tube filaments cause a-c hum by shorting, either partially or completely, to cathodes. Most modern tube checkers feature a *short* check, and readily locate the fault. The short cannot usually be detected with an ohmmeter, since it is only evident under operating conditions.

Worst Offenders

A-c/d-c receivers are usually the worst offenders in this respect, since the series-filament hookup creates high potential differences between the heater and cathode. Another cause of hum in these receivers is unequal filament voltage drops across the tubes. Excessive filament voltage usually occurs across the high-filament voltage tubes such as the 25L6 or 43. Such tubes should be replaced, since they not only short over the cathode, but the high emission resulting from high filament voltage creates audio distortion. This condition usually *creeps*, and is only evident after the tube has been in operation for some time.

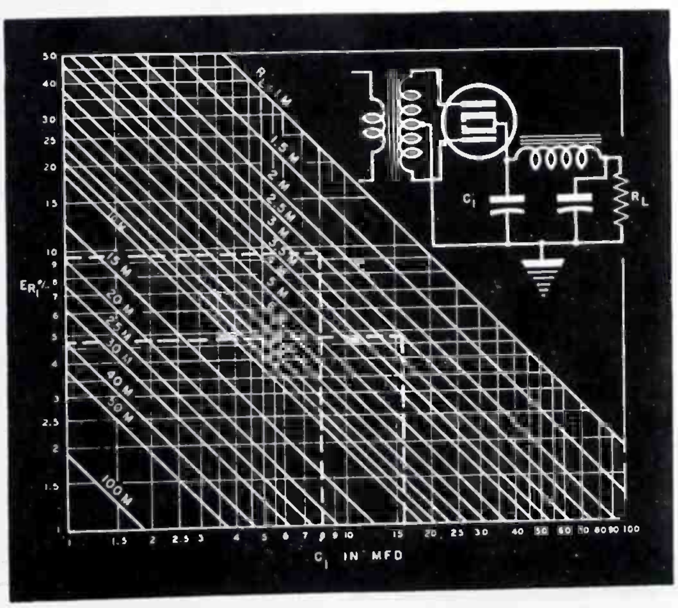
Filament Wiring Sources

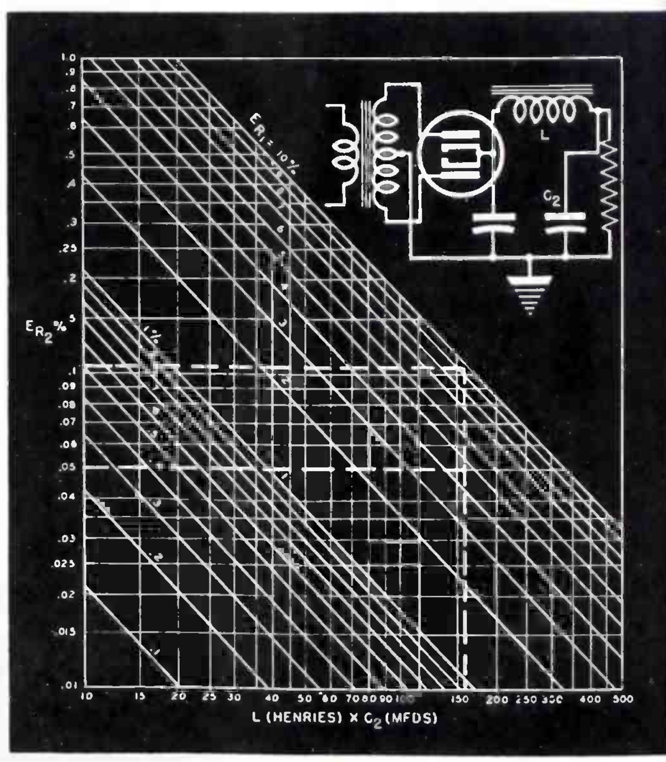
Filament wiring is also a source of hum. This, again, is more evident in a-c/d-c receivers than in conventional power-transformer types. The close quarters of a midget set make it difficult to dress the filament wires away from plate and grid leads. Where possible, this should be done, and, in addition, filament wiring should lie close to the chassis. Plate and grid leads should never run parallel to filament wiring. The effect of dressing one such lead away from the filament may not be evident, but the cumulative effect may be appreciable. In power-transformer sets, the same general rules apply. In addition, filament wiring that runs in pairs should be twined, or twisted.

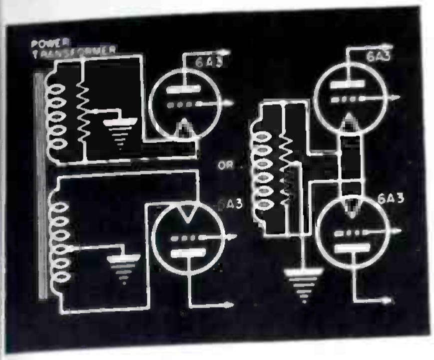
Radiation Hum

Power transformers and filter chokes sometimes cause hum by radiation, particularly, open channel or unshielded types, Fig. 1. This hum energy is transferred to audio transformers if the plane of the two cores is parallel. Changing the relative positions so that they are at right angles to each other, or moving them apart, will cure this. Where this is impossible, or where the pickup is by r-f or detector units, a metal shield inserted between the two units, may effect a cure. Again, grid

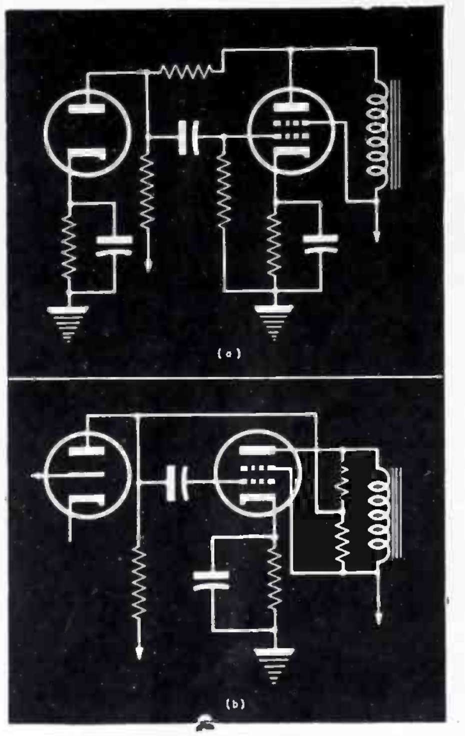
Figs. 3 *a* (below) and 3 *b* (right). In *a* we have a chart used for determining hum potential after the first filter condenser. Chart shown in *b* is used to compute hum potential after the *LC* filter.







Figs. 4 (left) and 5 (right). Fig. 4 shows two methods of neutralizing hum in filament type power tubes. In Fig. 5 we have two methods of inverse feedback which may be installed to reduce hum and improve audio quality.



AND CURES

and plate leads should be dressed away from power units. Filter units, such as electrolytic condensers, used in *B* supply filter networks, should not be mounted near r-f units, but kept close to the associated filter choke. Radiation from electrolytics will sometimes cause hum. Hum may also be transferred from the power transformer to the filter choke by radiation. It should be noted that in 60 cycle a-c receivers, hum is usually caused by the 120-cycle ripple present in the *B* supply. The filter circuit is designed for 120 cycles, and is only half as effective at 60 cycles; the 120-cycle ripple is a characteristic of full-wave rectifiers. When it is considered that the usual amount of hum voltage tolerated in an average receiver is .1 volt or less (in the *B* supply), it can be seen that it doesn't take much radiation to cause trouble. The same cures apply here as for audio transformers.

Filter Networks

It is important to consider the designs of power supplies, or *B*-voltage filter networks, when analyzing hum problems. Most filter networks consist of two filter condensers and a filter choke, Fig. 2.

The first condenser, C_1, materially reduces the hum or ripple voltage. Its effectiveness is determined by the load impedance after it, and is a function of the voltage across C_1, and the current drain of the receiver.

$$R_L = E/I, \text{ where}$$

R_L = load impedance in ohms, E = d-c output voltage in volts at C_1, I = load current in amperes

The charts in Fig. 3 show the effectiveness of a filter network, such as we have in Fig. 2, for 60-cycle receivers. A study of these charts provides a working knowledge of what to expect from filter systems, or additional filtering. Increasing the value of C_1 increases the output voltage of the rectifier in mc.. cases. Care must be exercised, when increasing its value that no undue strain is placed on circuit components, or that unduly high voltages are created. The degree of output increase may be obtained from tube data books.

Chart Application

To illustrate application of the charts, the following example is offered. Incidentally these data are also indicated on the charts in dotted lines.

In Fig. 2 the voltage at C_1 is 250 volts; current drain is 100 milliamperes; C_1 is an 8-mfd unit and C_2 has a value of 16 mfd; filter choke inductance is 10 henrys. Two problems are to be solved. (*1*) What is the ripple voltage in the B supply? (*2*) What would the ripple voltage be if C_1 were increased to 16 mfd?

Solution:

$$R_L = E/I = 250/.1 = 2500 \text{ ohms.}$$

The hum or ripple voltage, E_{R1}, in per cent, is found by drawing a line vertically along the 8-mfd point on Figure 3*a* to where it intercepts the 2500-ohm line. A horizontal line is then drawn to E_R%, which shows a ripple voltage of 9.4%.

Capacitor Effects

Referring to Fig. 3b, C_2xL = 160. We then draw a line vertically from the 160 point on C_2xL to where it intercepts between 9% and 10%, approximately .4 the distance between the two. A horizontal line then drawn to E_{R2}% shows an output ripple of .104%; .104% of 250 volts = .26 volt, which is the value we want. Placing a 16-mfd condenser at C_1 reduces this value to .05%, or .125 volt. These charts may be used for most rectifiers used in receivers, except gas types, and where the ripple after C_1 does not exceed 15%.

Hum Sources

Mercury-vapor type rectifiers, such as the 82, are also sources of hum. This hum condition is produced by radiation from the tube itself. These types should be well shielded, and isolated from other receiver components. In a-c/d-c sets, ballast tubes, particularly glass envelope types, may radiate hum. Shielding the tube, or other glass tubes near it, will cure this condition.

Hum In Audio Stages

Where filament types, such as the 6A3, are used in push-pull power stages, a hum balance may be obtained with a potentiometer across one of the tube filament supplies, Fig. 4. If only one supply is used for both tubes, the same system may be employed, but will not be as effective. For cathode-type output tubes in push-pull, matching the tubes for current drain equalizes the hum voltage in both sections of the output transformer, and the hum cancels out. This is only true for hum voltage present in the *B* supply, and is not true for hum introduced at the push-pull grids.

Negative Feedback

In any audio stage, if there is power to spare, some form of negative feedback may be used to reduce hum. Fig. 5 shows two representative forms of negative feedback that may be easily installed.

The detector, or first audio stage is

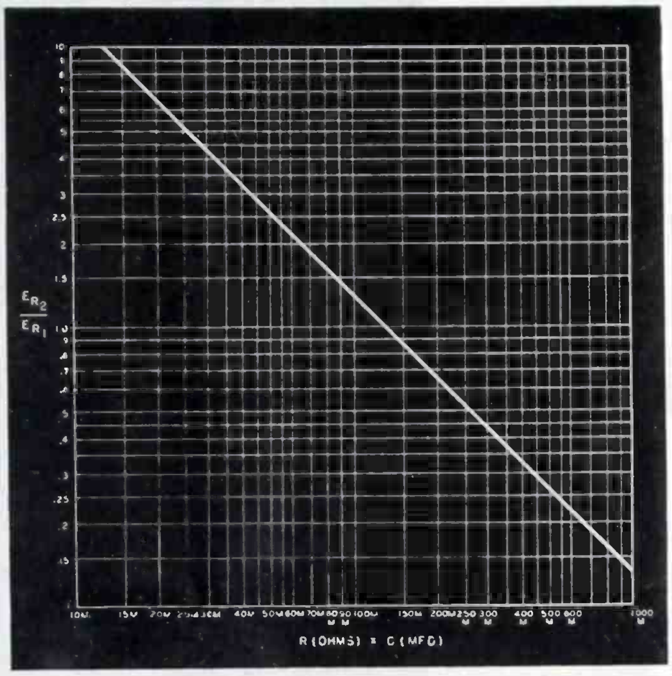


Fig. 6. A chart used in computing the effectiveness of *RC* filters.

or select a better position for it.

(*3*) Change the set location. In one case, the condition was caused by a steel *I* beam in the wall where the set was located.

(*4*) Connect two .05- to .25-mfd condensers across the line inside the receiver, grounded to the chassis; with and without an external ground.

(*5*) Insert a line filter.

(*6*) If there is any antenna wiring in the room, take the set into another room to learn if the inside wiring is picking up the hum.

(*7*) For a-c/d-c sets, ground the chassis through a .1-mfd condenser; sometimes, other values of condenser help. Reversal of plug polarity on a-c may help, too.

R-F Checks

When local conditions are not to blame, the r-f section of the receiver should be checked. We should check all r-f tubes for filament-to-cathode shorts, either with a tube checker, or by direct replacement. Particular attention should be paid to the d-c plate supply of the oscillator section of the converter tube. Additional bypassing or filtering at this point may help. In all cases, additional filtering of all r-f d-c supply voltages to both plate and screen grids should be tried.

the most common source of hum potential. Only a very slight hum voltage is needed at these points to produce an objectionable hum level at the speaker. A quick check for the responsible circuit may be made by bypassing audio plate and grid circuits directly to ground with some high value of condenser, .5 mfd or better. Start at the output stage and work back; when the point is found where the condenser has no effect on the hum, the previous circuit checked is the defective one.

Switch Covers as Source

Hum may arise by coupling from switch covers to the associated volume control. This condition may readily be detected by removing the switch cover from the control. The hum is usually due to solder paste or grime creating a hum path between the switch points and the resistance strip of the control, or its terminals. If cleaning with carbon tetrachloride does not help, replace the entire unit, or mount a line switch separately.

In high-gain amplifiers, additional bypassing may help. Some idea of the effectiveness of an *RC* filter may be gained from Fig. 6. This plot is based on the expression: hum or ripple output/hum or ripple input = $10^6/R\omega C$, where R = resistance in ohms, $\omega = 2\pi f$ or 753.9 for 120 cycles, C = capacity in mfd. *RC* filters are used in screen grid, control grid, and cathode and plate supply circuits.

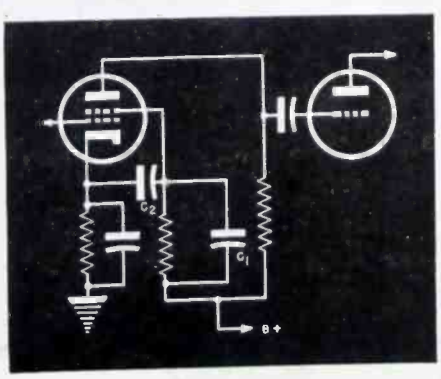


Fig. 7. A method of neutralizing tube hum in the screen grid circuit. C_1 and C_2 act as a divider circuit to introduce hum and cancel that present in the plate circuit.

Sometimes, hum may be neutralized, if the point of entry is known. Fig. 7 shows one such method. Here, C_1 acts to feed some hum voltage to the screen grid. Since this hum voltage is out of phase with that in the plate circuit, because C_1 and C_2 act as a hum voltage divider, the hum cancels out.

Hum in primary audio stages may also be reduced by reducing the filament voltage. We simply insert a low-ohm resistor in series with one of the tube filament leads to drop this voltage one or two volts. We must make sure that no other filament leads are attached to the socket terminal lug.

Modulation Hum

A condition frequently encountered in receivers, is modulation hum; that is, hum is evident only when a signal is being received, and not between stations. This may be due to internal or external causes. Quite often, the station signal energy is coming through stronger from the a-c line than from the antenna. Several possible cures are available; sometimes a combination of these helps. These are:

(*1*) Ground the electric outlet to a good ground; receiver grounds should also be checked.

(*2*) Increase the antenna length,

Other Hum Sources

Hum may originate in the speaker. Many electrodynamic speakers use hum bucking coils. Quite often, the leads from the hum bucking coil to the voice coil are reversed, particularly after a repair. They should always be checked for they may have been changed previously.

Grounding Points

The grounding point in a receiver is important. All bypassing units should be inserted at the socket directly to cathode. If one leg of the filament supply is grounded, we should not ground the cathode to the same point. Tying all grounds together may help.

It is important that all sockets and socket lugs are kept clean. A low-resistance path across a socket is often created by dirt, solder, paste or a burn. This is particularly true of wafer type sockets.

Generally speaking, we must remember that most hum conditions arise in circuits carrying a-c, and therefore all checking should begin at this point.

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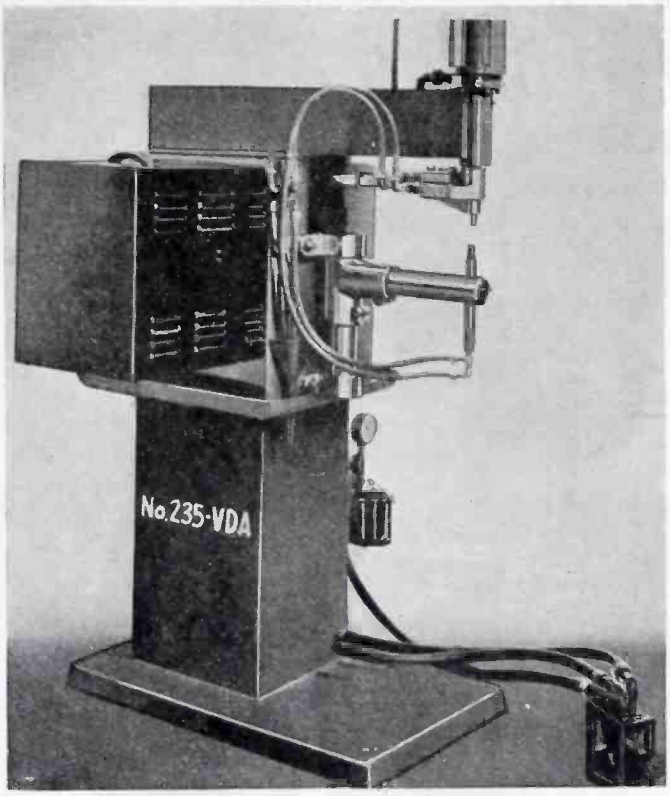


Fig. 2. A spotwelding machine. The pneumatically operated electrodes serve also as a clamp for the materials to be spotwelded. The welding transformer is usually housed in the base of the machine.
(*Courtesy Eisler Eng. Co.*)

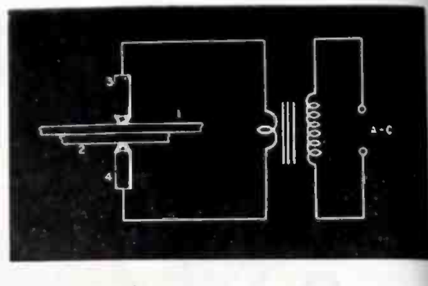


Fig. 1. A resistance welding circuit. Conduction of a-c through the relatively high resistance of the metal sheets *1* and *2* results in the loss of power, as heat, in the mass of the metal between the two low resistance copper electrodes *3* and *4*. This heating energy effects a *spotweld* between the metal sheets immediately between the electrodes.

ELECTRONIC SPOTWELDING-TIMERS

DESIGN AND SERVICE PROBLEMS

by S. J. MURCEK

SPOTWELDING affords a metal bond between two metal components. In the initial step the parts to be permanently united are placed into direct contact with each other. Small coincidental areas of each surface are then raised to fusing or melting temperature, which unite and, on cooling, form a single common bond. Inasmuch as the joint occurs only in a limited portion of the metals this joint is designated a *spotweld*.

So that only a limited area of each component is rendered molten, it is necessary to confine the required heating energy to this area. This is accomplished through the sudden release of the necessary heating energy within the confines of the described spot. Since metals are excellent conductors of heat, the energy contained in the heated metal spot is rapidly dissipated in the remaining mass of the metal once the weld is completed, and the temperature of the united metal components or parts is raised only slightly.

Spotwelding is useful because of the facility and rapidity with which the joint can be made, together with the attendant economy in the required heating energy.

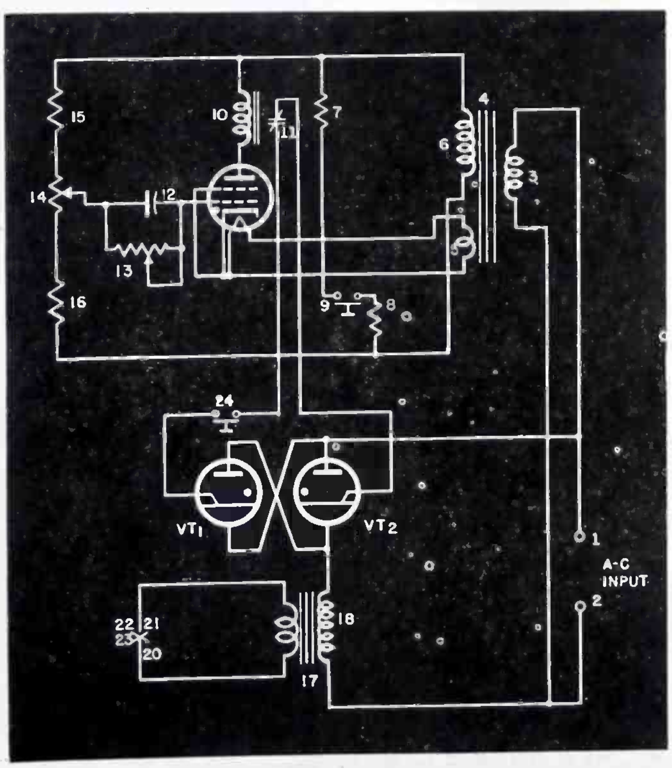


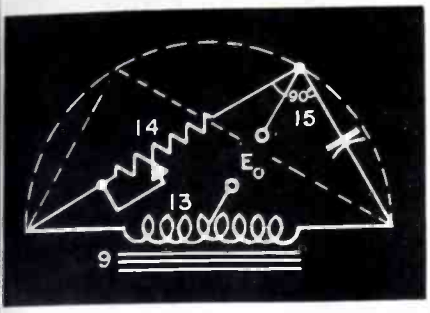
Fig. 3. Non-synchronous welding timing circuit, incorporating a 2051 thyratron. Circuit controls the GL-415 ignitrons through short-circuiting of the igniter electrodes by means of the timing relay contacts *11*.

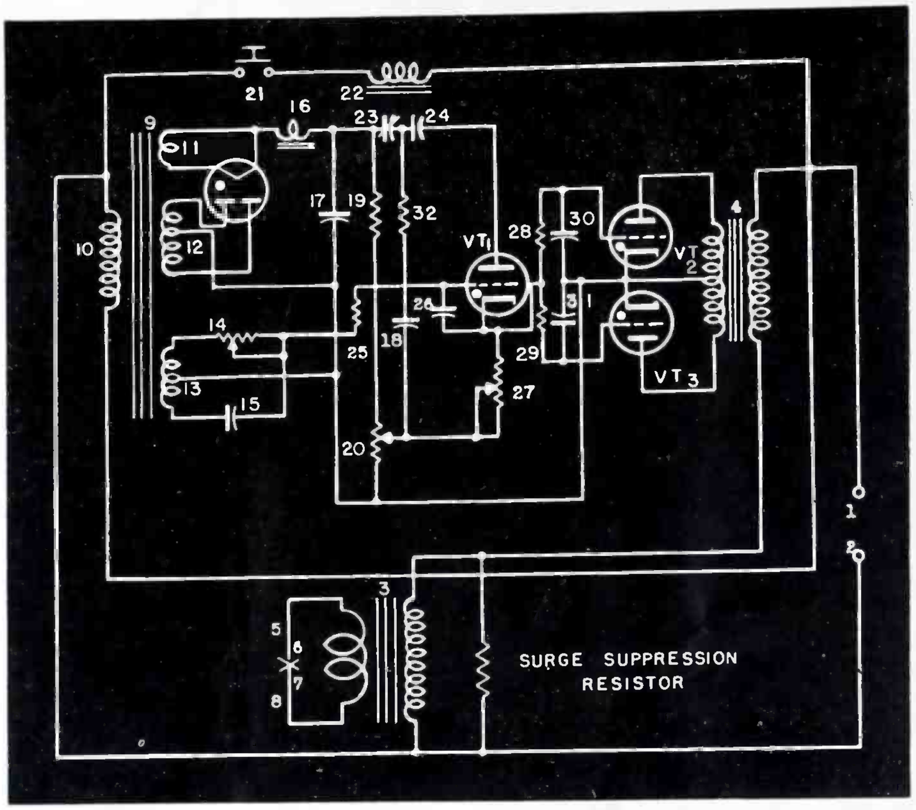
The Resistance Spotweld

The conduction of an electrical current through a conductive medium, such as a metal wire, is accompanied by the release of energy in the form of heat. Expressed in the familiar form: $W = I^2R$ where W represents the power dissipated in watts, I is the conducted current in amperes, and R is the resistance of the conductive path in ohms.

Since the temperature of any conductor varies as the square of the conducted current, this temperature may be readily increased through an increase in current, to such an extent that the conductor is rendered molten.

This electrical heating effect is readily applied to the electrical or *resistance* spot welding of metal machine parts. Fig. 1 illustrates how a resistance spotweld is effected. Two fabricated metal sheets





igs. 4 (right) and 5 (above). In Fig. 4, re have a synchronous impedance control imer. Here, the initial conduction of timing hyratron *1* is delayed by means of the hase-shifted a-c potential developed by he circuit until the arrival, in phase, of the power factor angle. Fig. 5 illustrates a esistance-capacitance phase shifter. Since he voltage across the capacitor *15* at-ains its maximum only after the capacitor s fully charged to the source potential, the oltage lags the current by 90°. Hence, al-eration of the rheostat resistance, *14*, results n an alteration of the phase-angle between he output voltage E_0 and the voltage across the transformer secondary winding, *13*.

1 and *2* are clamped between the points of the heavy copper electrodes *3* and *4*, which are connected to the secondary of an a-c stepdown transformer. When the primary of the welding stepdown transformer is properly energized, a heavy electrical current flows through the series circuit, represented by the transformer secondary, the welding electrodes, and the metal components.

Inasmuch as the resistance of the *work* metal is greater than that of the electrical welding circuit, electrical power is dissipated in this resistance to such a degree that it is heated to the fusing limit, forming the required bond. When the welding current stops, the welded metals cool to form a permanent bond. Illustrated in Fig. 2 is a small spotwelding machine suitable for the rapid bonding of small metal parts.

Control of Resistance Spotweld

A limitation is encountered in the application of the resistance spotweld; controlling the heating energy dissipated in the resistance of the weld spot. Release of excessive heating energy in this resistance results in the crystallization of the worked metal, and often in the actual *blowout*, or rapid oxidation of the molten spot metal. Again, dissipation of insufficient energy in the weld spot resistance results in an incomplete weld. To insure the formation of an acceptable spotweld, it is imperative that the quantity of energy dissipated in the spot resistance be maintained within limits.

This control is most readily applied to the welding current, either as a limitation of the amplitude of welding current, or its careful timing or *metering*. A major consideration in the application of time control to the spotwelding machine lies in the fact that its application obviates the use of welding transformer primary current control taps, reducing this operation to the mere adjustment of a single conveniently placed dial.

Accurate timing of the welding current is a necessity where the components to be welded are small, thin, or of highly resistive metals or metal alloys, to prevent crystallization during the welding process. The timing current *train* ranges from 0.008 to approximately 0.050 seconds, which is too limited a time interval to permit the proper operation of the usual control relay or contactor switch. Hence electronic control methods must be applied. Again we find that the primary winding of a welding transformer presents considerable reactive impedance to the supply voltage. This requires *synchronous* operation of the current control system to prevent the rise of disastrous current surges in the welding transformer primary circuit.

Electronic Resistance-Welding Control Devices

Electronic resistance-welding control devices may be classified as: (*1*) asynchronous devices, or (*2*) synchronous apparatus. That is, the apparatus operates either asynchronously or synchronously with respect to the supply source frequency.

The electrical circuit of an asynchronous welding timing system appears in Fig. 3. Only three electronic tubes are utilized in this system, assuring complete circuit simplicity. The tubes used are a single 2051 thyratron and the two GL 415 ignitrons.

In Fig. 3 the a-c power supply voltage across terminals *1* and *2*, energizes the primary, *3*, of the power transformer, *4*, heating the cathode of the 2051 thyratron through winding *5*. The ignitron tubes do not conduct at this time, since the relay contacts, *11*, are open.

Once the cathode of the 2051 attains operating temperature, the tube functions as a half-wave rectifier diode, utilizing only the cathode and grid electrodes of the tube. Since the contacts of the footswitch, *9*, are open, the current conducted by the thyratron is small. When the plate of the thyratron is instantaneously positive, with respect to the slider arm of the adjustable resistor, *14*, the cathode is also positive with respect to this electrode, and the series grid capacitor is not subjected to a charging current. However, during the succeeding half-cycle, the tube cathode is negative with respect to the resistor slider arm, and a charging current flows through the series grid capacitor, *12*. A succession of a few half-cycles is sufficient to charge the grid capacitor to a voltage level which is approximately equal to the crest value of that existing between the slider arm, *14*, and the plate of the thyratron.

The slider arm is so adjusted that the voltage existing across it and the upper terminal of the power transformer secondary, *6*, is appreciably greater than that which exists between it and the other terminal of the secondary. This is the timing circuit operating adjustment.

Closure of the footswitch contacts effects the closure of the contacts, *24*, the latter being in series with the ignitron exciter electrodes and the normally closed contacts, *11*, of the control relay, *10*. Since the thyratron tube does not conduct immediately, by reason of the charge present on the series-grid capacitor which holds the grid of the thyratron negative with respect to its cathode, the control relay contacts, *11*, remain closed, and the circuit between the two associated igniter electrodes is closed.

When the igniter electrodes of the respective ignitrons are connected together through the closure of the footswitch and relay contacts, these tubes conduct alternate half-cycles of a-c through the primary 18 of the welding transformer, *17*. An appreciably high current at low voltage, is induced in the secondary of this transformer, welding the work, *22* and *23*, through electrodes *20* and *21*. This welding current train begins to flow through the primary of the welding transformer immediately with the depression of the footswitch pedal, and may occur during any period in any half-

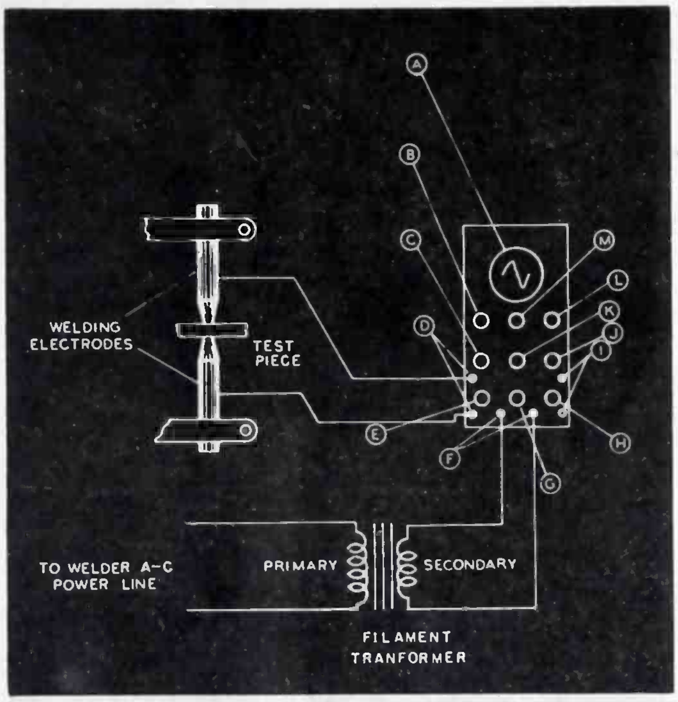


Fig. 6. Circuit for testing welding circuit power factor adjustment. Linear timing sweep of c-r oscilloscope is synchronized with welding input or source voltage to observe, on screen, any deviation of welding cycle amplitudes from the welding current average amplitude. *A*, c-r screen; *B*, intensity and a-c switch; *C*, vertical position; *D*, vertical inputs; *E*, vertical gain; *F*, external synchronizing voltage; *G*, horizontal amplifier switch; *H*, horizontal gain; *I*, horizontal inputs; *J*, horizontal position; *K*, sweep frequency; *L*, focus, and *M*, synchonizer gain.

cycle of the a-c supply frequency wave.

Meanwhile, the charge present on the series grid capacitor discharges slowly through the shunt timing control potentiometer, *13*, the rate of the capacitor discharge being dependent on the potentiometer adjustment. We must remember that the timer interval required to discharge the series grid capacitor to approximately one third of its initial charge potential follows the formula

$$t = RC \qquad (2)$$

where t is the discharge time in seconds, R is the shunt resistance in ohms, and C is the capacity in microfarads. Hence, the length of the welding-current train, in cycles, is readily adjusted by means of the timing control potentiometer, *13*, in Fig. 3.

Once the series grid capacitor, *12*, discharges to such a voltage that the grid of the thyratron is permitted to swing positive with respect to its cathode, the thyratron conducts, energizing the magnet coil of the relay, *10*, which is in series with the plate of this tube. When the coil of this relay is energized, the normally closed contacts, *11*, open, thus stopping conduction by the ignitrons, and the consequent flow of welding current.

Releasing the footswitch operating pedal, causes contacts, *9* and *24*, to open, opening the circuit between the igniter electrodes, and permitting the cathode of the thyratron to assume the same voltage level, with respect to its control grid, as that of the plate. This enables the atmosphere of the thyratron to deionize with the cessation of the plate current. Since the cathode of the thyratron is once again at the same potential as that of the plate, the tube reverts to operation as a gas diode rectifier and the series-grid capacitor is once again subject to the rectified charging potential, restoring the timing charge within a few half-cycles. The circuit is then prepared for the succeeding spotwelding operation.

Under practical considerations, the welding system described is usually manufactured as two separate units, one incorporating the timing circuit shown in the upper portion of Fig. 3, and including the timing relay, the other incorporating a case containing the ignitron sockets together with the necessary connector busses and terminals necessary to complete the circuit to the welding transformer primary winding.

A serious difficulty arises in the application of the asynchronous welding timing system when the duration of the welding current train is short and the current amplitude is high. The problem is further complicated by the fact that the secondary circuits of the conventional spotwelding machine are so arranged that the magnetic fields arising about each secondary conductor do not effectively neutralize each other, inasmuch as these conductors are widely separated. As a direct consequence, the inductance of the circuit which is connected to the low-voltage secondary winding of the welding transformer is highly inductive, presenting considerable reactance to the welding current train and creating current transients.

The presence of current transients in the welding system secondary or work circuit, where the length of the welding current train is of the order of a few cycles or less, is a serious factor in that the added welding current is often sufficient to cause the blowout or rapid oxidation of the material being welded. To obviate the difficulty arising with the presence of current transients in the spotwelding work circuits, welding timing circuits have been devised which operate *synchronously* with respect to the a-c supply voltage wave.

The electrical circuit of a synchronous spotwelding timer appears in Fig. 4. Phase-correction of the timing period in this circuit is obtained by means of a suitable phase-control circuit which incorporates the power factor adjustment rheostat, *14*, and the capacitor, *15*. These components are connected in series across the center-tapped winding, *13*, of the power supply transformer, *9*.

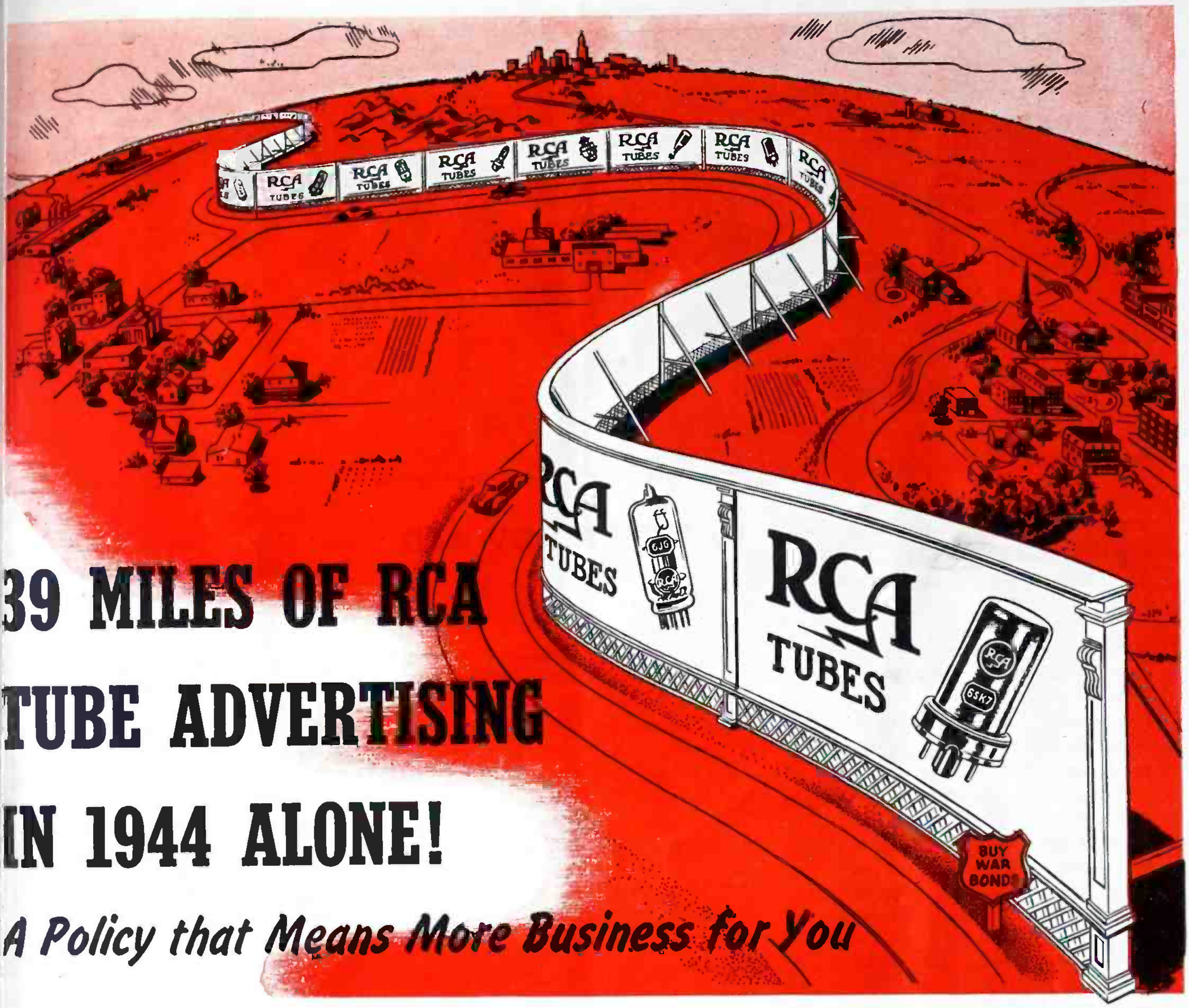
A descriptive diagram of the power factor timing correction circuit is given in Fig. 5. We note that the variation of the ohmic resistance of the power-factor-adjusting rheostat, *14*, effects a marked change in the voltage which appears across the capacitor, *15*. Inasmuch as the angular relation between the voltages appearing across the rheostat and the capacitor must always remain at 90°, the phase angle of the circuit output voltage E_o present across the circuit output terminals must vary with the alteration of the voltages appearing across either the rheostat or the capacitor. This conception may be more clearly visualized if it is considered that, with the reduction of the ohmic resistance offered by the power-factor-correction rheostat to zero, the voltage across the rheostat must also be zero, and the voltage across the output terminals of the circuit is in phase with that appearing across the secondary winding which supplies the circuit excitation voltage.

The voltage output of the phase-correcting circuit is in series with the control grid of the first timing thyratron, and therefore determines the a-c wave phase position at which this tube will begin to conduct. Further, the negative-grid biasing potential which maintains the control grids of all the thyratron tubes negative with respect to their cathodes is actually that present between the slider arm of the variable voltage dividing resistor, *20*, and the negative terminal of the d-c voltage supply source, the latter incorporating an 83 mercury-vapor rectifier. Hence, the voltage output of the phase-correction circuit is superimposed on the d-c biasing voltage component. The *1* thyratron is then rendered conductive when the voltage output of the phase-correction circuit neutralizes the bias potential. And inasmuch as the phase-angle at which this neutralization occurs may be altered by means of a phase-correction adjusting rheostat, conduction by the thyratron *1* may be initiated at any desired angle in any given half-cycle.

When the contacts of the footswitch, *21*, are open, the armature of the control relay, *22*, remains unsealed, thus leaving the break contacts, *23*, closed and the make contacts, *24*, open. Since the positive terminal of the timing capacitor, *18*, is connected to a common junction between these contact pairs, the capacitor is charged to the plate potential of the thyratrons. The charging current drawn by this capacitor is limited, in crest value, by the limiting resistor, *32*, which usually has a resistance of 500 ohms. Finally, since the make contacts, *24*, of the control relay remain open, the plate circuit of the thyratron, *1*, is subject to no plate potential, and the thyratrons *2* and *3* remain non-conductive.

With application of pressure to the control footswitch, the footswitch contacts, *21*, close, energizing the magnet coil of the control relay, *22*. The sealing operation of the relay armature causes the *break* contacts, *23*, to open, and the *make* contacts, *24*, to close, impressing the charge potential of the timing capacitor, *18*, across the timing control circuit comprising thyratron *1* and timing potentiometer, *27*. Thyratron *1* does not conduct immediately, however, inasmuch as the phase-controlled angular correction voltage which is superimposed on its grid-cathode negative biasing potential prevents such conduction until the arrival of the power factor angle, at which angle the correction voltage neutralizes the negative bias component. Once the power

(*Continued on page* 35)



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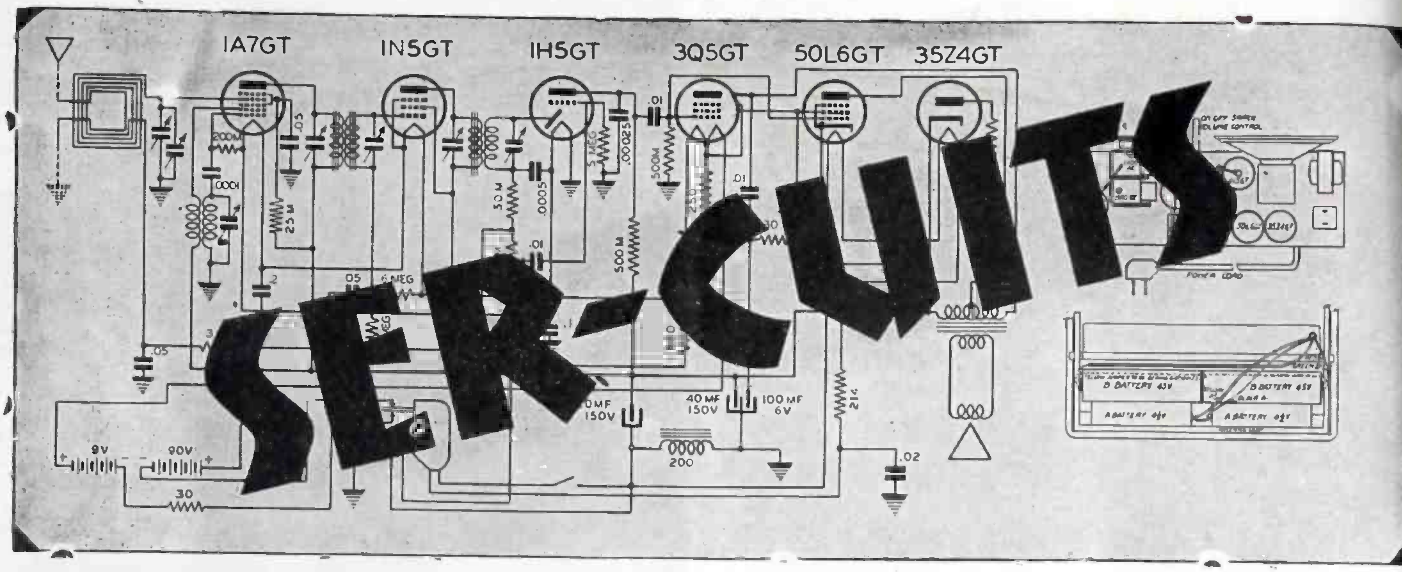


by HENRY HOWARD

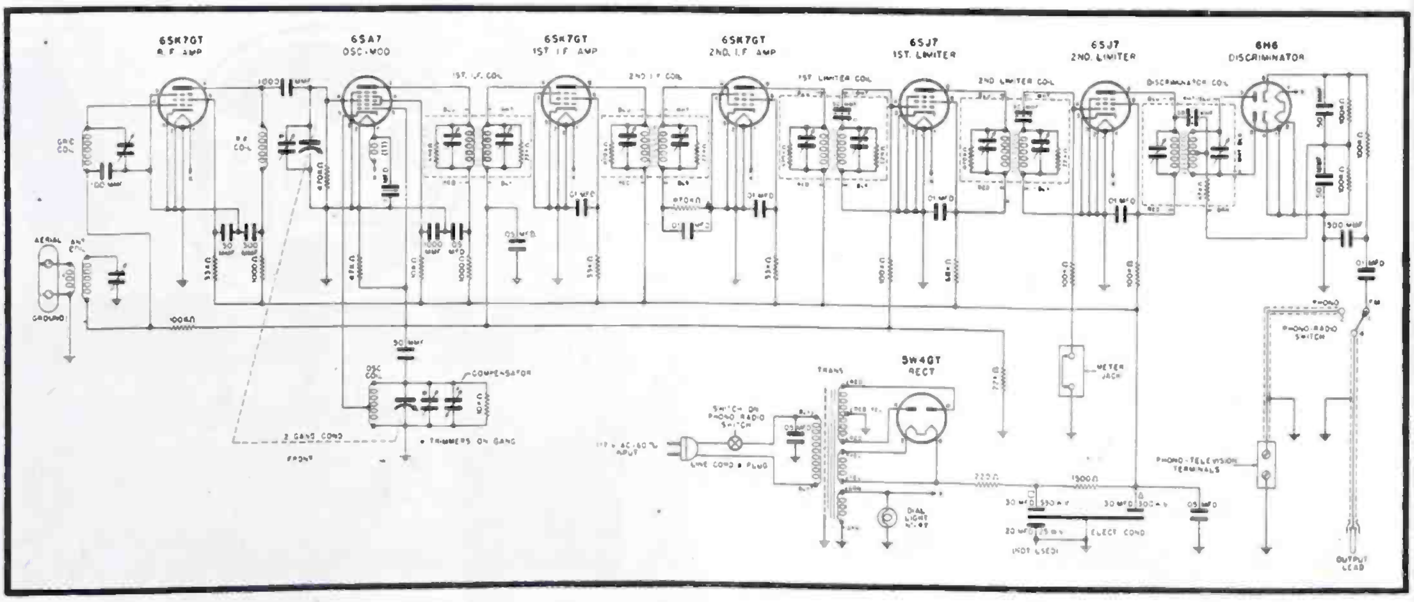
THE frequency-allocation hearings held recently in Washington have provoked extreme interest in f-m receiver design; methods of covering the bands, etc. The answers to many of the design problems are provided in the circuits shown in Figs. 1 and 2. In Fig. 1 we have an f-m model, Motorola FM-82. This model is designed to cover the 42-50 mc range.

An aperiodic r-f amplifier using a 6SK7 covers the 42-50-mc band, providing some gain and serving to couple the dipole antenna to a 6SA7 converter. A broad-band antenna transformer applies signal voltage to the low side of the r-f grid coil, the signal appearing across a 100-mmfd buffer condenser. The tuned detector circuit is composed of an r-f load coil in the 6SK7 plate, a 1,000-mmfd blocking capacitor and one section of the two-gang condenser. The other section of the gang condenser tunes a cathode-tap Hartley oscillator. An r-f choke is used in the 6SA7 heater.

Two 6SK7 i-f amplifiers are coupled with iron-core wide-band transformers using damping resistors across both windings. They all have 22,000-ohm units shunting the secondaries. The amplified 4.3-mc i-f signal is fed to two 6SJ7 limiters and then to a 6H6 discriminator. Avc developed across a 22,000-ohm resistor by the first limiter is fed to the r-f and first i-f stages. The converter bias is only the drop across a 470,000-ohm grid leak; the second i-f is the same.

The first limiter operates at a lowered plate voltage obtained through a 68,000-ohm common plate-screen drop resistor. The second limiter operates at a still lower voltage, the dropping resistor being 100,000 ohms. This limits the amplitude of the signal that can be passed by these stages, tending to make all signals have equal amplitudes. A meter jack for tuning is provided. This is in series with the 100,000-ohm grid leak of the second limiter.

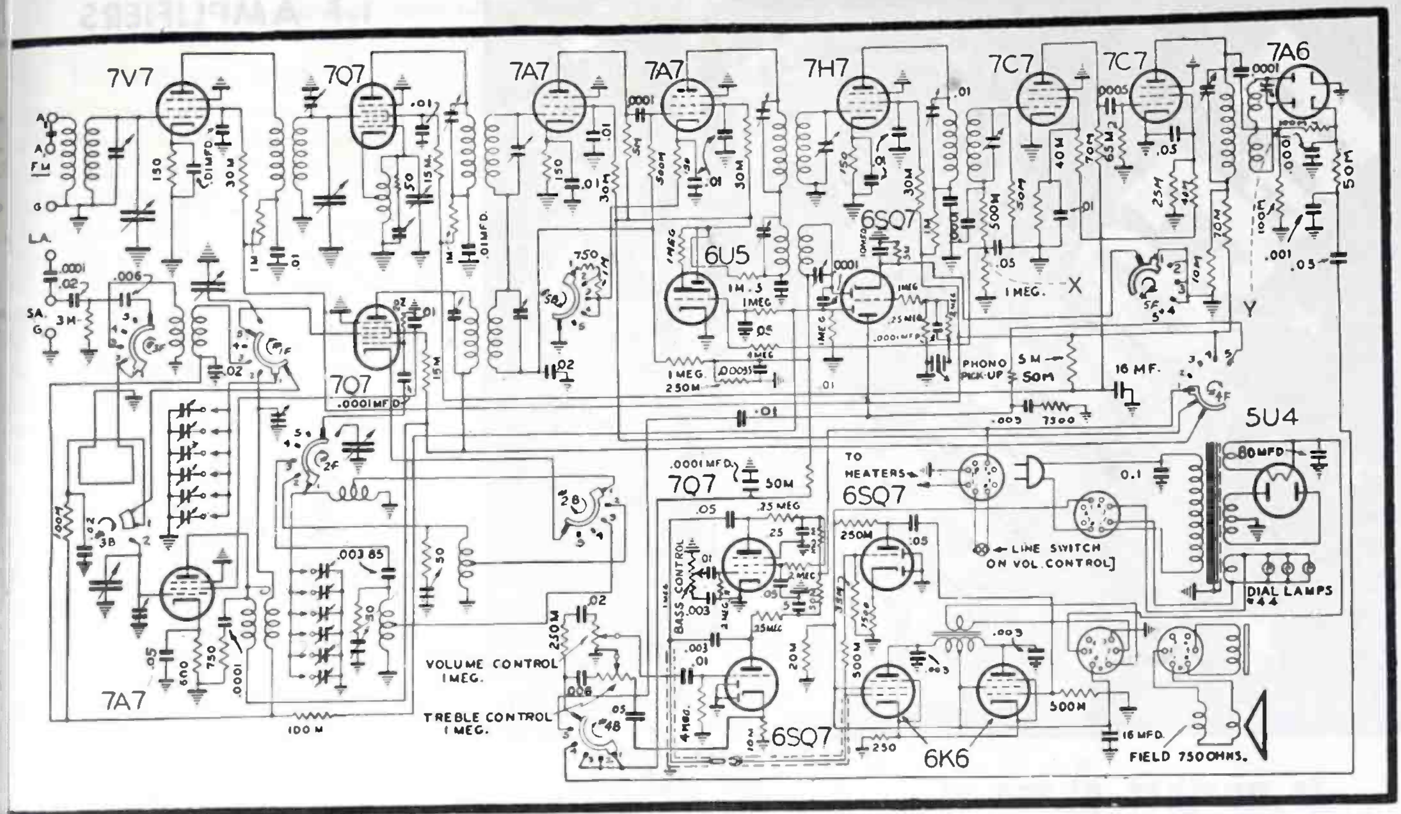
Fig. 1. Motorola FM-82 receiver designed to cover the 42–50 mc band. The i-f amplifiers are coupled with iron-cored wide-band transformers.



Garod 3 P 1812

In Fig. 2 we have a combination a-m/f-m/s-w receiver, Garod 3 P 1812. Separate a-m and f-m channels are provided, but two i-f stages serve for both. Tuned r-f stages are used for both channels, a 7A7 for a-m and a 7V7 for f-m. And a 7Q7 is used for each converter. The f-m oscillator does not use the conventional grid-condenser grid-leak bias. Instead, it uses a direct grid connection with no bias.

Two 7A7s with resistance coupling between them serve as i-f amplifiers for the both channels. Since the frequencies are so widely separated (455 and 4,300 kc), there is little difficulty. For instance, the choking action of the 4.3-mc coil is small at 455 kc, causing little signal loss; also, the i-f tuning condenser of the 455-kc section be-



omes a very effective bypass at 4.3-mc. Thus the signal loss there is mall.

A third tuned i-f stage with a 7H7 s used for f-m only. This feeds two 'C7 limiters and a 7A6 discriminator. The a-m i-f is fed to a 6SQ7 diode de-ector whose triode section is used as a phono pickup amplifier. A 6U5 eye s operated from both the 6SQ7 second

Fig. 2. Garod 3 P 1812 combination a-m/f-m/s-w receiver.

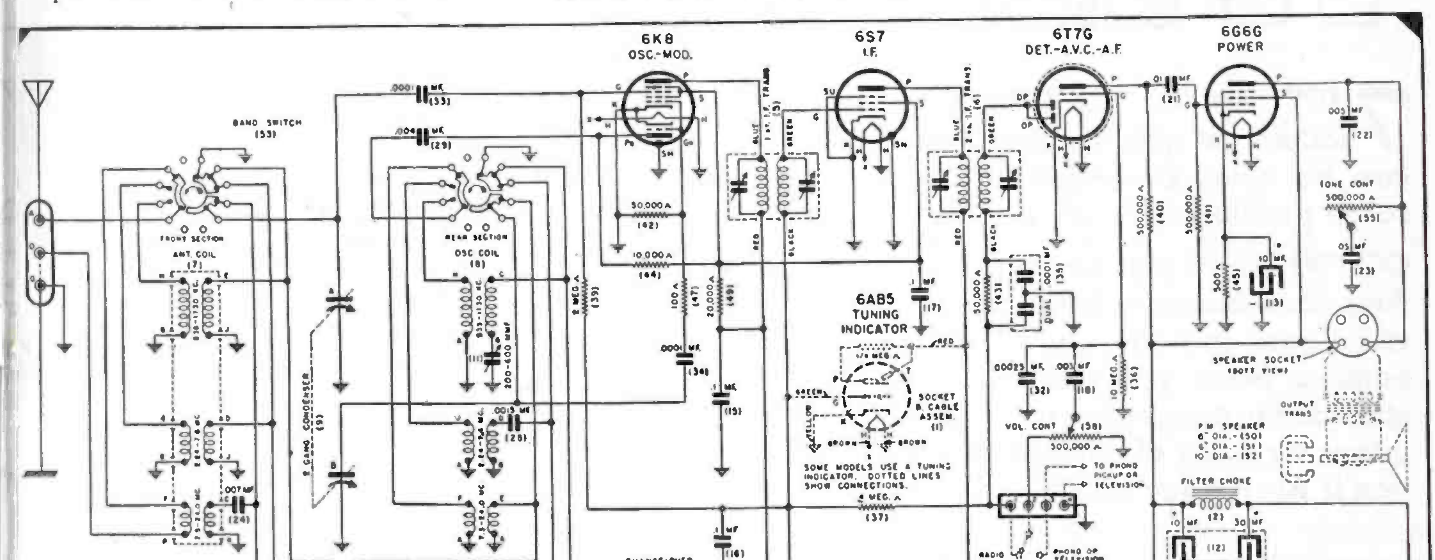
diode avc and the grid leak circuit of the first limiter. R/C filters eliminate the i-f components, leaving only the d-c bias.

The a-f amplifier consists of a 6SQ7

Fig. 3. Sentinel 237, a-c/battery receiver. R-f choke *A* isolates rectifier heater.

feeding a pair of 6K6 with the aid of another 6SQ7 phase inverter. A 7C7 is run in parallel with the first audio for bass tone control. In the control system the input capacity is reflected to the plate circuit, a .01-mfd shunt capacity and potentiometer being used in the grid circuit. The tube operates in an inverted manner, there being no

(*Continued on page* 31)



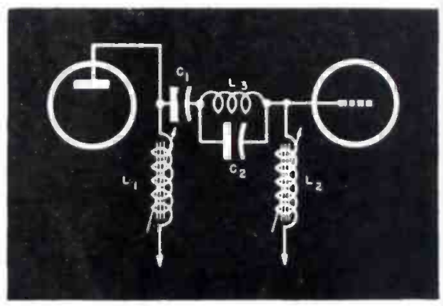
I-F AMPLIFIERS

(*Continued from page* 14)

the gain requirements, not a simple assignment. The pictures suffer in definition where the full band is not passed. An additional requirement of television amplifiers is the complete rejection of the sound channel and, also, the sound channel of the adjacent channel. This is usually accomplished by wave traps, as in Fig. 9, which shows one type of i-f circuit with two iron-core tuned inductors coupled through C_1 with the trap in series. This trap L_3-C_2 is tuned to 8¼ mc to reject the sound channel or to 14¼ mc to reject the adjacent sound channel. One transformer may be set for the latter and two for the former, depending upon the strength of available television stations.

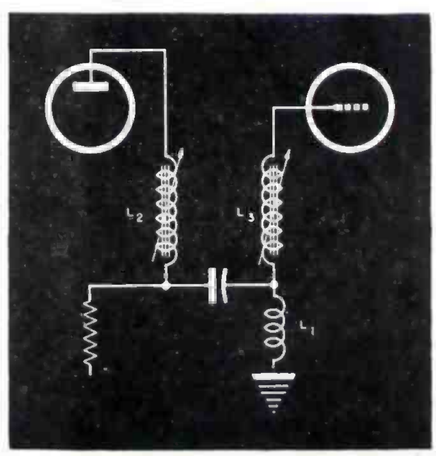
Inductive Coupling

Fig. 10 shows another type of coupling system with similar tuned inductors, but coupled inductively by means of a common coil, L_1. Correct constants and coupling provides the proper bandwidth and gain. Still another type of coupling is shown in Fig. 11. This transformer is capacity tuned as in low-frequency units but has an adjustable coupling capacitor



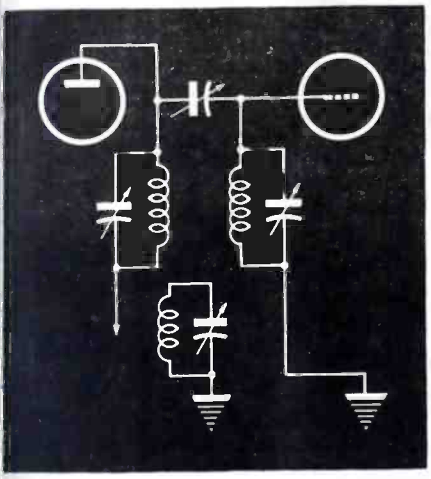
Figs. 9 (above) and 10 (below)

Fig. 9 illustrates a trap circuit used in the i-f system of a television receiver. In Fig. 10 we have iron-cored units used in an inductively-coupled circuit.



etween plate and grid for bandwidth djustment. The wave trap is situated etween the two coils, and thus is couled to both. There is little doubt that till other designs will be forthcoming s soon as television sets start rolling ff the assembly lines. The Service lan will have to be quite alert to these evelopments to provide rapid yet uality servicing.

ig. 11. A capacity method of i-f control n a television system is illustrated here. An djustable coupling capacitor between plate nd grid is used. A wave trap between the f coils serves as a bandwidth control.



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SER-CUITS

(*Continued from page 29*)

signal applied to the grid. The treble tone control is a 1-megohm unit connected between the first audio cathode and the high side of the volume control through a .006-mfd capacitor.

In this receiver all suppressors in the r-f and i-f pentodes are connected to ground rather than cathode, giving a negative rather than a zero bias.

Sentinel 237

In Fig. 3 appears an interesting a-c/battery type receiver, Sentinel 237, with a high-fidelity audio system. Many innovations have been included in the power supply system to eliminate hum and other possible power noises to improve audio output. The power transformer, for instance, is not only very large, but it has a tertiary winding. To isolate the rectifier heater from the remainder of the tubes, an r-f choke, *A*, is used. This choke supplements the conventional *A* filter from the vibrator.

BUY WAR BONDS TODAY!

FIXED RESISTORS

(*Continued from page* 18)

value), some thought should be given to the matter before choosing an available resistor that is either *higher* or *lower* in value than that indicated as being required. Generally, where the voltage drops to be developed across resistors are somewhat critical, as in audio-bias resistors and in the grid-load dividing resistors in audio-phase inverter circuits, the resistance tolerance allowable usually is only ±10%. The resistors used for most of the other receiver functions are not so critical, and a tolerance of ±20% is usually allowable for them. Only in special cases are ±5% tolerance resistors used in home or auto radio receivers.

Accordingly, when the use of other than an *RMA Preferred Resistor* value is indicated it is, of course, desirable to choose the resistor of nearest *RMA* preferred value to it, either larger or smaller according to the characteristics of the circuit. For instance, let us assume that the value of a needed cathode-bias resistor is calculated to be 110 ohms. Now the nearest values in the ±10% tolerance group of *RMA* preferred value composition resistors are 100 ohms, and 120 ohms. In such a case before making a decision to use one or the other the plate and screen voltages should be taken into consideration. If the plate and screen voltages of the particular receiver tend to run high, then it is desirable to use the resistor that will provide more bias (to safeguard tube life and operating characteristics) and therefore the 120-ohm unit should be used. If these voltages tend to run low, the lower value resistor should be used. The same reasoning applies to screen and plate resistors, etc., which are in general not as critical as the cathode-bias resistor, and for which a resistance tolerance of ±20% usually is permissible.

Determining Wattages

After the resistance value is determined in this way, the correct wattage rating to employ may be found by the most suitable method explained under case (*1*).

In case (*3*) there are several alternatives:

(*a*)—The correct resistance and wattage rating of the resistor may be secured from either the schematic circuit diagram or the parts list of the receiver in a service manual (observing the proper precautions previously mentioned).

(*b*)—If the receiver is an *orphan* or *brand* receiver not listed in the manuals, it may be possible to proceed as in *2* (*c*), applying the formula E/I for calculating the required resistance and either I^2R, E^2/R, or IE for calculating the power dissipated.

(*c*)—If the foregoing procedure is not desirable or possible, a variable resistor of suitably large resistance range may be temporarily substituted in the circuit in place of the faulty unit. Its value should be adjusted until the currents and voltages in the affected circuits associated with the electrically nearest tube or tubes are correct as specified by a tube characteristics chart listing this type of tube (or until a listening test indicates that the receiver is operating most satisfactorily). The resistance of the variable resistor at this setting may then be measured with an ohmmeter, and a fixed resistor of nearest *RMA* preferred value to this, and of power rating which may be determined by either of the methods already explained previously here, may be permanently connected into the circuit. Substitution variable resistor units designed especially for such work were available to Service Men before the war. One such, having a resistance range from 100 to 100,000 ohms, is illustrated in Fig. 3.

Fixed Wire-Wound Resistor Applications

Because the materials used in their nstruction are better able to with-and the effects of moisture and con-nued heating at elevated tempera-ires, fixed wire-wound resistors (es-ecially those of the vitreous-enameled ype) possess properties fundamentally fferent from the fixed-composition pe in that they have greater pre-sion, stability and power-handling bility. A wire-wound resistor will ot readily change in value, nor does s resistance vary very much between s cold and normal hot state. How-ver, mainly because they are more xpensive than composition resistors of milar rating, fixed wire-wound re-istors ordinarily are used in radio re-eivers only for those functions where nore power must be dissipated (in ex-ess of about 2 watts) or where greater esistance stability or accuracy is eeded than is possible with the less xpensive composition resistors. Such unctions are relatively few, so that rdinarily not more than one or two xed wire-wound resistors are usually ound in a modern receiver. Their use

(*Continued on page* 34)

FIXED RESISTORS

(*Continued from page* 33)

usually is confined to line-voltage dropping in a-c/d-c receivers, bleed circuits, grid bias to high-power output tubes, filament current control in battery-operated receivers, etc. Ordinary commercial wire-wound resistors used for these purposes are almost entirely of ±5% tolerance.

Fixed Wire-Wound Resistor Troubles and Repairs

A wire-wound resistor may become open due to a break occurring in the resistance wire. Such breaks may be caused by mechanical strains set up in the wire by the expansion and contraction caused by the normal heating and cooling of the unit during intermittent service, the break usually occurring at or near the junctions of resistance wire and terminal lugs; by kinks or dents introduced during the winding process; and by actual melting of the wire at some point due to excessive heat developed during severe overload. The insulation between adjacent turns may break down, resulting in arcing and eventual burnout between them. Such troubles will be revealed by simple ohmmeter tests. Often the break is such that the contact between the two ends alternately opens and closes, causing symptoms of either intermittent reception, intermittent volume changes, noise, etc.

Wire-wound power resistors now are rather scarce so it often is necessary for the Service Man to try to repair a faulty unit if reasonably possible. A break in the resistance wire usually may be located by careful visual inspection. In the adjustable-type resistor, the break may be traced out with an ohmmeter by connecting one ohmmeter probe to an end terminal of the resistor and sliding the other probe along the bared contact surface of the wire until the exact spot of the break is determined. In either case the break can then be bridged by sliding an ordinary narrow adjustable-type contact band or lug to each side of the break, tightening them in position, and then joining them with a jumper wire, as shown at (*a*) of Fig. 1. In the case of a non-adjustable type resistor (which does not have a bared track in its wire), it will be necessary to scrape the insulation from a few turns of the resistance wire at the point where the contact buttons of the bands will make contact. The bands should be narrow so they do not short out more than about 5% of the total resistance.

In many cases it will be found possible to effect satisfactory bridging of the break by employing only one of these contact bands. This is an advantage, for then less of the total resistance is shorted out by the repair.

This method is far superior to merely twisting the two ends of the wire together at the break, for when this is done a noisy or otherwise troublesome contact inevitably results when the wire later becomes oxidized.

Faulty contact between the resistance wire and the terminal contact bands or lugs also is a frequent source of trouble. This condition may result in noisy reproduction, intermittent reception or volume changes; or excess heat may be developed that ultimately causes the resistor to open.

The Remedy

The obvious remedy for this condition is to carefully remove the terminal contact band or lug; then slip an adjustable sliding contact band over the wire in its place, previously having cleaned the wire where the contact button of the sliding band is to make contact with it. The band should then be fastened securely in place. The resistor now will look as shown at (*b*) of Fig. 1.

A ground sometimes occurs when one of the end-metal mounting brackets that fasten a vitreous-enameled resistor to the receiver chassis manages in some way to touch the end terminal clamp or lug adjacent to it. An ohmmeter continuity test will reveal this condition. A washer made of fibre or other suitable insulating material properly inserted between the bracket and the lug will remedy this trouble.

Partial Shorts

A metal-clad wire-wound resistor may develop a ground, or a partial short circuit, if the insulation breaks down and the resistance element touches the metal shell. A simple ohmmeter continuity test between the resistance element and the metal casing (with all connections to the resistor terminals open) will reveal this condition. The receiver circuit diagram should always be consulted when a grounded condition is discovered, however, for in some receivers such resistors are intended to be grounded at a certain point.

Poor internal contact at one of the taps on a metal-clad resistor often may be corrected by simply inserting a small screwdriver between the receiver chassis and the resistor's metal casing (the casing usually is riveted to the receiver chassis at each end) at the faulty tap and bending it up, as illustrated in Fig. 4. The dent thus made in the casing forces the tap into more intimate contact with the resistance winding without affecting the unit in any other way.

ELECTRONIC TIMERS

(*Continued from page* 26)

factor phase-arrival condition is attained, control grid of thyratron *1* swings positive with respect to the cathode, and the tube begins to conduct.

The discharge of the timing capacitor is limited, in time, by the ohmic resistance of the timing control potentiometer, as in the non-synchronous welding timer circuit of Fig. 3, and as is indicated by the simple timing equation, *2*. Since the charge potential, which exists across the terminals of the timing capacitor is impressed across the resistance of the timing potentiometer, (the arc drop potential across the thyratron plate and cathode being only 15 to 18 volts) this potential exceeds the negative biasing potential which exists between the control grids and cathodes of thyratrons *2* and *3*. Consequently, the control grids of the rectifier thyratrons swing positive and these tubes conduct, effectively short-circuiting secondary of impedance transformer, *4*.

When the thyratrons do not conduct, the impedance present across the primary of the series impedance transformer, *4*, is infinite, preventing the flow of a-c through the primary winding of the welding transformer, *3*. Since the thyratrons

(*Continued on page* 36)

(Continued from page 35)

conduct during the timing capacitor discharge, an effective short circuit is present across the primary of the series impedance transformer, permitting the maximum welding current to flow.

Generally, the negative-biasing potential which is present between the slider arm of the voltage divider resistor, *20*, and the negative terminal of the d-c power supply is adjusted to approximately that value to which the timing capacitor is charged. Under these biasing conditions, the control grids of the rectifier thyratrons swing negative when the potential across the timing potentiometer decreases to a value less than that to which the negative biasing potential is adjusted. This cuts off conduction by the thyratrons, and the welding current train. We note that the initial conduction by thyratron, *2*, which controls the initial half-cycle of a-c supply voltage impressed across the primary of the welding transformer, is prevented, until the phase-correction voltage swings the control grid of the timing thyratron *1* positive. Since this initial condition occurs on the phase-arrival of the power-factor angle, spurious energy storage in the inductance of the welding circuit is avoided, and the circuit provides satisfactory spotwelds with timing periods as short as one-half cycle.

Reopening of contacts, *24*, stops thyratron conduction, permitting the tube atmosphere to deionize and the control grid to regain control over further conduction by the tube. Further, the positive terminal of the timing capacitor, *18*, is reconnected to the positive terminal of the d-c power supply, permitting the capacitor to recharge.

Installation, Maintenance, and Servicing of Welding Timers

For servicing resistance-welding timing units it is wise to have a complete spare timing unit; the unit is simple in construction and low in initial cost, and will be mighty handy in emergencies when the timing unit fails to operate properly. The initial purchase should also include a spare ignitron tube. These tubes are subject to failure when the water-cooling pressure falls below the necessary value. This occurs often under the best of installation conditions.

It is important to inspect the wiring between the power-circuit control circuit-breaker or switch and the welding transformer primary winding. This must be of the correct diameter or cross-section, to insure maximum possible delivery of welding current at the welding electrode tips. The a-c applied to the power transformer of the welding timing unit is best wired to the primary winding of this transformer through a separate switch or fused breaker. This will aid in subsequent servicing and maintenance operations. The leads between the igniter electrodes and the timing unit must be of ample cross-section. These data appear in the ignitron switching cabinet instruction booklet accompanying the unit.

If the welding timing system fails to function properly, the thyratron timing tube should be tested in a suitable tube tester. This tube will develop faulty control characteristics after long use. We must remember that the thyratron in Fig. 3 is subject to continuous operation, even during idling periods, since it functions as the timing capacitor charging rectifier. Defective ignitron tubes can be detected quite readily. If only one of the ignitrons conducts during the welding cycle, the normal hum developed in the laminations of the welding current transformer changes to a distinct rumble. This indicates that energy is being dissipated in the inductance of the transformer primary winding because of the rising magnetic saturation of the transformer core, occasioned by the half-wave rectified a-c delivered to the primary winding. In addition, the conduction by a single ignitron is unsteady due to the counter voltage developed by the collapse of the core field between individual a-c half-cycles. Other indications of defective ignitrons include the sudden rise in the circuit power demand with the cessation of conduction by one ignitron, lack of a visible glow in the tube jacket, which usually can be seen through the glass seal of the plate lead, and a rapid check of the igniter electrode resistance. The latter check is completed with the tube in the normal position, to determine whether the igniter electrode is open or excessively high in resistance.

Should incorrect operation of the welding system be due to a defect in the timing unit, other than a defective thyratron it is advisable to remove the entire timing unit, replacing it with the spare timing unit to provide uninterrupted operation of the production line until repaired.

Defective operation of the timing unit due to circuit defects are readily recognizable. Thus, if the voltage divider resistor, *7*, which is a wire-wound unit, often subject to failure in the presence of moisture, is eventually open-circuited, the timer will fail to operate inasmuch as the timing capacitor, *12*, will fail to recharge. Further, the relay armature will close immediately with the operation of the footswitch, preventing delivery of a welding current train to the welding transformer primary winding, regardless of the timing potentiometer setting. A similar condition is present when the carbon molded resistor, *16*, fails due to absorption of moisture, or to overheating; the latter is caused by the control grid of the thyratron being held positive during the positive alternations of the a-c supply voltage wave.

Discontinuities in the control of the timing range are due to the presence of an open circuit in the resistance element of the timing potentiometer, *13*, in Fig. 3. Here, it is obvious that the length of the welding current train, prior to the operation of the timing relay, *10*, is unusually long. This results in overheating of the spotweld when the slider arm of the potentiometer is rotated beyond the position of the open circuit.

Although the resistors, *16* and *17*, in the voltage divider are of the plastic cased type, and are subject only to light load dissipation, except during the charging of the timing capacitor, when resistor, *16*, is subject to the conduction of a surge current, these resistors are often found to change value. This results in a marked change in the timing control dial calibration. Failure of the wire-wound resistor, *8*, which is of the vitreous enamel coated type, prevents the operation of the timing circuit, inasmuch as the cathode of the timing thyratron cannot be placed at the correct voltage level.

The tests employed in determining the condition of the electrical components of the timing unit, such as the timing control potentiometer and the voltage divider resistors, are similar to those utilized in the analysis of radio component troubles.

Since the welding timer unit is of the a-c type, all the voltage measurements, except one, should be made with an a-c voltmeter. The voltmeter used in making these measurements should present an impedance of at least 1000 ohms-per-volt, and preferably higher. The a-c potentials in the timing circuit are usually given either in the manufacturer's instruction booklet for the timing unit, or are shown on the circuit diagram or blueprint, which will be found on the inside of the cabinet cover. If these voltages are not given, it will be necessary to calculate the values through the application of Ohm's law.

Even though the proper operating voltages for the timing unit are unknown, voltage tests are of incalculable value in the location of defective components. If resistor, *16*, in the voltage divider is open, for example, the voltage reading taken across this resistor will approximately equal that present across secondary winding, *6*, of the power supply transformer. The same test holds for the condition of the resistors *15*, *17*, and *9*, the latter being taken with the footswitch depressed. An open circuit in the winding of the relay magnet coil may be readily detected by means of the voltage test, if a 1-mfd

(*Continued on page* 38)

(*Continued from page 37*)

capacitor is connected in series with the a-c voltmeter. Here, if the a-c voltmeter reads approximately one half the potential which appears across the control resistor, *7*, when the footswitch is depressed, then the magnet coil is open-circuited, since the voltmeter reads the half-wave average value of the potential due to its rectification by the thyratron.

A defective ignitron is readily located by means of the a-c voltmeter. In Fig. 3, if both ignitrons conduct during the timing cycle, the voltmeter should read approximately 15 volts. If, however, the voltmeter reads approximately one-half the a-c line voltage applied to terminals *1* and *2*, then one of the ignitrons is not conducting and the voltmeter will read the average half-wave value of the a-c line voltage. The defective ignitron may then be identified directly by determining which of the two ignitrons glows during the conduction period, or by determining which water jacket is at the highest temperature. No glow, or heat will indicate a faulty tube.

The installation, maintenance and servicing of the welding timer of Fig. 4 are similar in all general respects to the Fig. 3 timer, although this circuit is an impedance system which does not employ ignitron tubes. However, determination of operational troubles is, in many respects, less difficult, since the timing circuits are d-c operated. The installation of this type system does not warrant the purchase of a spare emergency unit unless more than two similar timers are arranged in a given production line. Hence, maintenance and servicing operations must generally be carried out rapidly and decisively in order to obviate production line delays. In general, no synchronously operating welding timer commercial installation can be provided with spare units unless more than several similar units are incorporated into a given production line.

To provide rapid repair of synchronous spotwelding timers, the Service Man must familiarize himself with the nature of the timer operation under various conditions involving circuit defects. Here, the visual inspection of the timer operation serves, in most instances, to provide a ready diagnosis of the difficulty under consideration, rather than volt and ohmmeter readings. The latter instruments should be considered useful only in confirming a diagnosis.

Thus, if the timer functions as to provide erratic welds, the operation of the rectifier thyratrons *2* and *3*, in Fig. 4, should be carefully observed. A faulty tube will be indicated by a lack of an intense blue glow within the glass envelope, probably because of an open heater, or of the end of its useful life, the latter being indicated by the severe blackening of the glass envelope. An a-c voltmeter reading, such as that described for the test of a defective ignitron, except that the voltage involved appears between one terminal and the center tap of the impedance transformer, *4*, will confirm the diagnosis.

A discontinuity in the operation of the welding-timer-range potentiometer is indicative of an open resistance element. Thus, when the slider arm of the potentiometer is adjusted to a position beyond the break in the resistance element, the length of the welding current train increases infinitely, causing oxidation of the material being spotwelded. Again, if the timer refuses to conduct a welding current train at any setting of the potentiometer, resistor *20*, in the voltage divider is open-circuited on the negative side of the slider arm. This open circuit increases the thyratron grid-cathode d-c negative bias to a level approximating that present across the output terminals of the d-c power supply.

Continuous conduction by the rectifier thyratrons, with the timing thyratron *1* dark and the footswitch in the released position, may occur under either of two conditions: the loss of the d-c power supply output voltage, or the failure of the voltage divider resistor system above the positive side of the resistor, *20*, slider arm. The first condition can be immediately determined by inspection of the 83 mercury-vapor rectifier tube. If this tube glows with an intense blue glow, the filter capacitor, *17*, is short-circuited and must be replaced. Lack of a glow in this tube indicates that the tube is defective, and must be replaced. The second condition may be tested for by operation of the footswitch. If, with the depression of the footswitch operating pedal, timing tube *1* glows, either resistor, *19* or *20*, is open.

Erratic welding, including oxidation of the spotweld material and sputtering at the electrode tips, indicates incorrect adjustment of the phase-correction system. This condition usually occurs after the welding machine operator alters the arrangement of the secondary winding loading circuit, which increases the welding-circuit inductance if the area encompassed by the conductors of this circuit is materially increased.

Incorrect adjustment of the phase-correction circuit is readily analyzed on the screen of a cathode-ray oscillograph. The latter device is connected to the circuit system as shown in Fig. 6. Here, the vertical amplifier input terminals are connected across the welding electrode tips, and the external synchronizing voltage terminals are connected across the secondary winding of a filament transformer. The synchronizing operation for the oscillograph is best carried out prior to testing on the timer output. This procedure involves the connection of the *vertical amplifier* input terminals temporarily across the terminals of the filament transformer secondary winding, together with those of the *synchronization* input terminals. The image is then adjusted to contain several full a-c cycles. The *vertical amplifier* input terminals may then be disconnected from the filament transformer and returned to their original position across the welding electrodes, placing the oscillograph into conditions for the examination of the welder output waveform.

The testing of the waveform present across the welding electrodes should be performed under actual working conditions; a suitable test piece should be inserted between the electrode tips for each operation. It may be necessary to increase the amplification of the resulting signal voltage by the vertical amplifier since the working voltage varies only from 2 to approximately 15 (a-c).

Operation of the timer footswitch produces an output waveform on the oscillograph screen. The timing should be so adjusted that the welding current train consists of but one or two *complete* cycles, as viewed on the screen. If, under these conditions, the initial half-cycle of the welding current train is of greater amplitude than that of the remaining waveform, the phase-correction circuit of the spotwelding timer is incorrectly adjusted. This condition is corrected by adjustment of the phase-correction rheostat so that the initial half-cycle of the welding current train is of the same amplitude as that of the remaining portion of the welding current train.

In general, replacement of voltage-divider resistors and variable resistors and potentiometers in any welding timer results in the alteration of the timer dial calibration. When such a replacement is made, therefore, it is advisable to recalibrate the timing dial. This is best accomplished with the aid of a suitable interval timer. One timer, made by the International Standard Time Corporation, incorporates a synchronous electric clock, and described in a recent paper[1], is admirably suited to this operation. Dial calibration consists of recording of the various weld current trainlengths, in cycles or thousandth-seconds, obtainable at given points equally spaced along the dial scale.

In conclusion, we must remember that many electronic timer failures arise from tube failures or defects. Therefore it is wise to carry as wide a stock of suitable tubes as is possible today.

[1]S. J. Murcek, *Special Electronic Test*, SERVICE, May, 1944.

NEWS

HARRISON RADIO JAMAICA BRANCH HOLDS SERVICE MEETING

The Jamaica, N. Y., branch of Harrison Radio was host recently to several hundred Service Men at a special meeting and equipment demonstration.

Roy Goodwin, manager of the RCA Test and Measuring division, discussed test equipment. He predicted that no startling or new equipment was expected at the end of the war, except for television test equipment.

Irving Wolf, manager of the Jamaica store, analyzed service equipment availability. He pointed out that some equipment is available only to ex-servicemen of this war. He said that some types of test units are available on an AA5 for replacement purposes only, but on a 6 to 12 months delivery basis. According to Mr. Wolf the tube situation is fair. April, May and June deliveries should be better, he indicated. Transformers are frozen, he said, although they may be obtained by using WPB form 1682.

Art Liebscher of RCA offered interesting demonstrations of a plastic case meter, and the new audio chanalyst. The meter, hermetically sealed, has a viewing pane that is part of the case. This case—and the movement container is made of plexiglass. In case of failure, an entirely new unit can be inserted. The meter has a 200-microampere movement. Alnico is used for the magnet.

Mr. Liebscher explained that the audio chanalyst semi-portable unit was particularly designed for the repair of intercommunication and p-a systems. A speaker and an amplifier are part of the unit. It also has an impedance-measuring unit.

Motion pictures of Signal Corps equipment on the front lines, the electron microscope and r-f heating in industry were also shown.

* * *

SCIENTIFIC ELECTRIC ELECTRONIC HEATING BOOKLET

A 16-page booklet devoted to electronic heating, has been released by Scientific Electric, 107-119 Monroe Street, Garfield, New Jersey.

The booklet offers a brief record of the historical background and development of electronic heating, explains the principle of its operation, describes the two chief methods and fields of application and lists many proved present-day uses. Many illustrations are supplied. Several types of h-f generators are shown.

* * *

CAPTAIN ALBERT GOFFSTEIN RETURNS TO ATR

After more than three years of military service, Captain Albert Goffstein has returned to the American Television & Radio Co., St. Paul, Minnesota, to resume his position as general manager and chief engineer.

As a reserve officer, Captain Goffstein was called to duty on February 7, 1942, and was assigned to the staff of the Chief signal officer in Washington, D. C. After nine months in Washington Capt. Goff-

(*Continued on page* 46)

OLD TIMER'S CORNER

by SERVICER

WE were sitting around in the Legion Hall the other evening after the meeting and talk drifted around to Pete who was the most popular Service Man in the county. Since we were all more or less in an easy-going mood, we asked him to join us and tell us how come.

"Well, fellows," Pete said, "it isn't difficult to become popular, if you work at it. Nothing comes for nothing, you know."

"Tell us just what you do that makes it work?" Ed queried. "We'd sorta like to follow your ideas."

"Remember old man Joyce who lived back there in the farming section towards Berryport? Well, his son gave me the idea which I think was the start of it all.

"One day, Joyce stormed into the shop with an antiquated chassis under his arm. Seems like his boy, the one who just got the Purple Heart we heard about today, had been tinkering and had jimmied everything pretty badly. Not only wouldn't the set play, but it was cross-connected and lumpy soldering seemed to be all over. Several condensers turned up blown out and heaven knows what else.

"I told old man Joyce that he ought to send his boy down to see us, so that if he were really interested in radio, we could sorta make his acquaintance and he could see just how we did things. Also he could carry the repaired set home as a sort of punishment, we thought.

"Well in about a day and a half, a tall boy—grimy and dirty—but with bright eyes and a look about him that reached right out to your heart, came into the store. He didn't even have shoes on, and his big toe had the inevitable bandage on it. Of course it was summer, and the farm children were used to walking around like that, but still we were startled.

"He sorta sidled up to me and said that his paw had told him that he had best come down to see me and the damage he had done to the set. He told me that he had tried to fix it, but somehow or other he "jest didn't get the hang of sech things easy." Then I found out that he had walked the three miles into town and that he planned on walking back the same distance.

"Son," I told him, "you seem to be interested in this radio. And your dad ain't any too well pleased with what you did. Neither will he be better pleased after he sees our bill. What got into you to do such a thing; and why didn't you bring it right down to us for repair?"

"The youngster just stood there with his mouth wide open and fidgeted around from one foot to the other. "I don't know," he said, "but radio sure is wonderful to read about, and I figured that after I had read everything in the library I could fix anything. Guess I ain't so smart as I thought I was. And I'm powerful sorry that I broke up paw's radio."

"After I drew him out a bit, I found that he had really read every radio book in the public library. That wasn't much, because some of the books were for engineers only, and he wasn't more than 17 and had had nothing but local schooling.

"He hung around while I fixed the set, and his eyes glistened when I used the meters and the various test instruments. I kept telling him what I was doing and I soon found out that he had a nice radio foundation, even though somewhat sketchy.

"Finally, since he seemed sorry to leave with the fixed set, I asked him how he would like to work for me after school each day. Before I could finish the sentence, he had said, yes. I knew that he'd have to walk six miles every day to work; but I sure felt that he was interested in radio if he would do that. So I arranged with him to start the following Monday at $6 a week (which was all I could afford then) doing odds and ends, and learning radio.

"Well, you fellows can believe it or not, but he brought the queerest assortment of friends with him. One or two came every day, and they got into my hair,

(*Continued on page* 43)

RECORD PLAYER

(See Front Cover)

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A high-level crystal pickup feeds a 2-megohm volume control through a .01-mfd capacitor. A 250,000-ohm equalizer shunted across the tube input attenuates the low frequencies. The output circuit consists of a .01-mfd unit shunting a p-m speaker.

A 100-ohm surge limiting resistor is inserted between the rectifier positive output and the first filter capacitor, 100 mfd. This resistor also contributes toward the filtering. A second-stage resistance capacity filter consisting of 3,000-ohm and 20-mfd units supplies the screen voltage. The plate is supplied from the first filter. A .02-mfd 600-volt molded paper condenser bypasses line disturbances which might reach the amplifier grid. A .01-mfd blocking condenser keeps the ground side of the crystal isolated from the a-c line.

POSTWAR PHONO-PICKUP CONFERENCE

Ray T. Schottenberg and W. J. Doyle, sales managers of the jobber and manufacturer divisions, respectively, of Astatic Corporation, discussing postwar products with F. H. Woodworth, president, at new plant in Conneaut, Ohio.

SERVICING HELPS

ZENITH 6D410, 411, 413, 414, 425, 426, 427, 446, 455 (Chassis No. 5659, 5660, 5663, and 5664)

High pitched whistle: Caused by condenser C_8 (mounted on condenser gang) opening. Replace defective .1-mfd 200-volt condenser.

Audio oscillation and howl: Caused by coupling between audio output plate circuit and the diode load bypass condenser. Dress 35L6 plate lead (green wire) away from diode load bypass condenser, C_6. Replace the 150-ohm and 27-ohm resistors even though they check okeh.

Weak reception: Caused by low Q i-f transformer. Check for broken strands of litz wire in i-f coil leads. Sandpaper the ends and resolder them at their terminals.

Noisy when jarred: I-f leads touching each other or the coil shield, or a poorly grounded i-f coil shield can is cause of trouble. Remove shield can and dress coil leads. Then resolder the shield can in place to assure a positive ground.

Off calibration and mistracking between converter and oscillator circuits: This is due to the 100-mmfd oscillator grid-coupling condenser changing capacity.

Set dead and yet tubes and voltages check okeh: This is due to leaky or shorted diode load bypass condenser. Replace the mica in the dual 100-mmfd diode load bypass condenser assembly (.

Distortion and double talk: Carbonized wire-wound 150-ohm 35L6 cathode biasing resistor and the 27-ohm rectifier protecting resistor are cause of trouble. Remove the leads to condenser C_4 and adjust its capacity to 90 to 100 mmfd. Then resolder the leads and align the receiver.

High level line hum: This is caused by a-c line coupling into first audio grid circuit. Shield the brown lead between diode load bypass condenser and the *B*— end of volume control. Connect the shield to *B*—.

Zenith Shop Notes

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ERRATA

The plate lead of the second input tube, 7G, in the February cover diagram should not be grounded.

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OLD TIMER'S CORNER

(*Continued from page* 41)

it the lad did his work, and did it well. Besides he was learning.

"About six months after he went to work for me, he came in proud as a peacock and showed me his amateur radio license. Then, and before you could say Jack Robinson, I found that the boy and his pals had formed a radio club and I had been elected honorary president.

"Now here's what I wanted to tell you. Because I became friends with that one boy, and through him with practically all the kids his age in the neighborhood, I soon found that I had a corps of highly efficient publicity men going around saying. . . . "If its broken, take it to Pete." They helped more than a lot of the advertisements which I had been putting out in the *Evening Bugle*.

"Eventually, the lad finished schooling and became my best Service Man. Not only did everybody know him, personally from long contact, but everybody knew he was on the way to making a success of himself. All that brought me more business, since almost anybody liked to see a lad succeed and will give him a hand up. I finally had to give him a small share of the profits of the shop. We were doing fine until the War grabbed him off.

"I'm very proud of him, and I sure will be among the first to welcome him home. We need him!

"And that's how I did it! There is no easier way to become popular than to *rate* with the youngsters. It sure does pay off!

"So the next time some youngster drags himself into your shop and asks you what appears to be fool questions, don't turn your back on him or shoo him out of your shop. He may be your future business partner staring you right in the face. He can be your best loudspeaker, too!"

"Well!" was all we could say.

NEWS

HARRISON RADIO JAMAICA BRANCH HOLDS SERVICE MEETING

The Jamaica, N. Y., branch of Harrison Radio was host recently to several hundred Service Men at a special meeting and equipment demonstration.

Roy Goodwin, manager of the RCA Test and Measuring division, discussed test equipment. He predicted that no startling or new equipment was expected at the end of the war, except for television test equipment.

Irving Wolf, manager of the Jamaica store, analyzed service equipment availability. He pointed out that some equipment is available only to ex-servicemen of this war. He said that some types of test units are available on an AA5 for replacement purposes only, but on a 6 to 12 months delivery basis. According to Mr. Wolf the tube situation is fair. April, May and June deliveries should be better, he indicated. Transformers are frozen, he said, although they may be obtained by using WPB form 1682.

Art Liebscher of RCA offered interesting demonstrations of a plastic case meter, and the new audio chanalyst. The meter, hermetically sealed, has a viewing pane that is part of the case. This case—and the movement container is made of plexiglass. In case of failure, an entirely new unit can be inserted. The meter has a 200-microampere movement. Alnico is used for the magnet.

Mr. Liebscher explained that the audio chanalyst semi-portable unit was particularly designed for the repair of intercommunication and p-a systems. A speaker and an amplifier are part of the unit. It also has an impedance-measuring unit.

Motion pictures of Signal Corps equipment on the front lines, the electron microscope and r-f heating in industry were also shown.

* * *

SCIENTIFIC ELECTRIC ELECTRONIC HEATING BOOKLET

A 16-page booklet devoted to electronic heating, has been released by Scientific Electric, 107-119 Monroe Street, Garfield, New Jersey.

The booklet offers a brief record of the historical background and development of electronic heating, explains the principle of its operation, describes the two chief methods and fields of application and lists many proved present-day uses. Many illustrations are supplied. Several types of h-f generators are shown.

* * *

CAPTAIN ALBERT GOFFSTEIN RETURNS TO ATR

After more than three years of military service, Captain Albert Goffstein has returned to the American Television & Radio Co., St. Paul, Minnesota, to resume his position as general manager and chief engineer.

As a reserve officer, Captain Goffstein was called to duty on February 7, 1942, and was assigned to the staff of the Chief signal officer in Washington, D. C. After nine months in Washington Capt. Goff-

(*Continued on page* 46)

OLD TIMER'S CORNER

by SERVICER

WE were sitting around in the Legion Hall the other evening after the meeting and talk drifted around to Pete who was the most popular Service Man in the county. Since we were all more or less in an easy-going mood, we asked him to join us and tell us how come.

"Well, fellows," Pete said, "it isn't difficult to become popular, if you work at it. Nothing comes for nothing, you know."

"Tell us just what you do that makes it work?" Ed queried. "We'd sorta like to follow your ideas."

"Remember old man Joyce who lived back there in the farming section towards Berryport? Well, his son gave me the idea which I think was the start of it all.

"One day, Joyce stormed into the shop with an antiquated chassis under his arm. Seems like his boy, the one who just got the Purple Heart we heard about today, had been tinkering and had jimmied everything pretty badly. Not only wouldn't the set play, but it was cross-connected and lumpy soldering seemed to be all over. Several condensers turned up blown out and heaven knows what else.

"I told old man Joyce that he ought to send his boy down to see us, so that if he were really interested in radio, we could sorta make his acquaintance and he could see just how we did things. Also he could carry the repaired set home as a sort of punishment, we thought.

"Well in about a day and a half, a tall boy—grimy and dirty—but with bright eyes and a look about him that reached right out to your heart, came into the store. He didn't even have shoes on, and his big toe had the inevitable bandage on it. Of course it was summer, and the farm children were used to walking around like that, but still we were startled.

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Zenith Shop Notes

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•

OLD TIMER'S CORNER

(*Continued from page* 41)

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• • • on or about July 1st,
SERVICE
will be located in new and larger quarters at
52 VANDERBILT AVENUE, NEW YORK 17, NEW YORK

NEW PRODUCTS

G. E. MULTIRANGE TESTER

A multirange tester instrument, typ UM-4 Unimeter, which operates from to 10,000 volts at 20,000 ohms-per-volt o d-c, has been developed by G. E. On a- Its range is from 0 to 10,000 volts at ap proximately 5,000 ohms-per-volt.

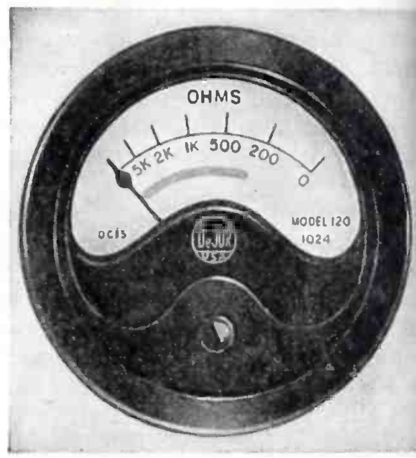
Direct-current ranges extend from 10 microamperes to 10 amperes in 6 step and resistance measurements are provide from 3,000 ohms to 10 megohms in 5 steps

* * *

DEJUR-AMSCO MINIATURE METERS

A hermetically-sealed, ring-mounted miniature 1½" meter, model 120, has been announced by DeJur-Amsco Corp., Northern Blvd. and 45th St., L. I. City 1, N. Y.

Instrument flange may be mounted on 1/16" to ¼" panels. A waterproof gasket is supplied for sealing to the panel. Available in a wide variety of ranges, including highly sensitive microammeter or microvolt-motor requirements. Built to A-S-A specifications.



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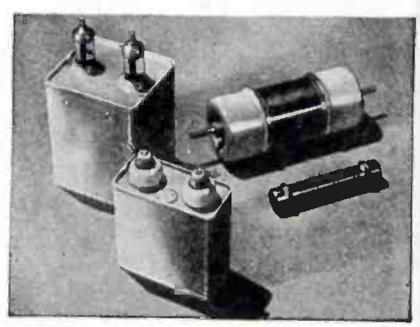
SPRAGUE OIL CAPACITORS

Capacitors, type 25P, utilizing a new Sprague oil impregnant, *vitamin q*, that are said to operate satisfactorily at thousands of volts at ambient temperatures as high as 105° C, have been announced by



Sprague Electric Company, North Adams, Mass.

Standard types include hermetically sealed rectangular metal container capacitors in styles for 95° C and 105° C, continuous operation, and in d-c rated voltages from 1,000 to 16,000 volts. Other types include type 45P hermetically sealed in glass shells with metal end caps.

* * *

U.M.C. D20 DYNAMIC MICROPHONES

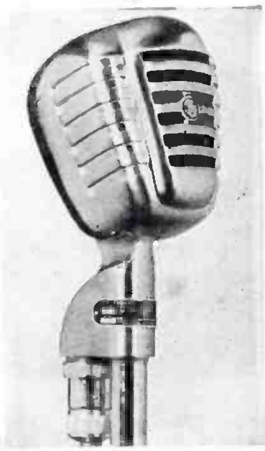
Four models of the dynamic response microphones, D20, have been announced by Universal Microphone Co., Inglewood, California.

Mounted on micro-adjust swivel. Unit may be positioned throughout a 60° angle.

Designed for use indoors and outdoors with a frequency range of 50 to 8000 cycles at —54 db as referred to one volt per bar.

Standard ⅝"-27 thread stand coupling. Dimensions: 2⅝" wide, 3" high, 3¼" deep; shipping weight, 3¾ pounds.

Available in 50, 200, 500, and 40,000-ohm models.



* * *

IDEAL GLOW LAMP TESTER

A circuit tester, *lo-volt test glo,* for testing circuits from 5 to 50 volts, a-c/d-c, has been produced by the Ideal Commutator Dresser Company, 4035 Park Avenue, Sycamore, Illinois.

Uses an incandescent *glow lamp* protected by a transparent plastic housing. Overall length is 7". Insulated test leads are 4" long.

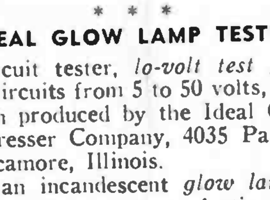
* * *

MARION 2½" AND 3½" METERS

Meters of 2½" and 3½" (d-c) size that are said to be completely hermetically sealed have been produced by Marion Electrical Instrument Company, Manchester, New Hampshire.

Meter mechanism is built into a protective cup-like frame, with glass cover, sealed to the metal rim. Window sealing process was developed in cooperation with the engineers of the Corning Glass Company.

Use of magnetic shielding is said to provide panel interchangeability without affecting calibration.



NEWS

(*Continued from page* 40)

stein was transferred to headquarters of the 11th Air Force in the Aleutians, where he served as Assistant Signal Officer.

Upon his return to the United States on December 5, 1943, he was reassigned to the Equipment Laboratory, Engineering Division of the Air Technical Service Command, Wright Field, Dayton, Ohio, as Assistant Technical Executive . He held this post for approximately fourteen months.

* * *

MECK EXPANDS

Complete occupancy of their buildings in Plymouth, Indiana, has been announced by John Meck Industries, Inc.

Meck says that they can convert their war plant quickly to civilian production and produce 2,000 home receivers per day.

* * *

PHILCO SERVICE PLANS

A world-wide organization of appliance Service Men including radio, has been announced by the Philco Corporation. A membership of 25,000 is expected in the next two years.

Membership is open to individual Service Men, dealers' Service Men, and dealer organizations both in the United States and other countries which have and maintain facilities adequate to carry on high quality work. Members will be informed as to the latest technical developments and will be instructed in maintenance and repair work. One of the features of the program will be a standard labor charge schedule.

Robert F. Herr, vice president, is in charge of the Philco service department.

* * *

OHMITE CONTRIBUTES $15,000 TO ILLINOIS TECH.

The Illinois Institute of Technology has received a grant of $15,000 from the Ohmite Manufacturing Company for the establishment of the Ohmite Laboratory for Precision Measurements.

The gift was made by David T. Siegel, president of Ohmite, and a trustee of Illinois Tech.

The laboratory's ultimate goal will be to provide precision electrical measurements for the Chicago area approaching in accuracy those of the Bureau of Standards in Washington, D. C.

The laboratory will be located at the Armour Research Foundation of Illinois Institute of Technology and will be developed under the direction of Prof. E. H. Schulz, supervisor of electrical engineering laboratories, and L. W. Matsch, supervisor of electrical engineering in the Armour Research Foundation.

* * *

CONCORD RADIO CATALOG

A 68-page catalog listing standard lines of condensers, resistors, transformers, tools, testers, tubes, etc., has been published by Concord Radio Corporation, 901 W. Jackson Boulevard, Chicago 7, Illinois; 265 Peachtree Street, Atlanta 3, Georgia.

* * *

McMURDO SILVER OPENS PLANT

An engineering and manufacturing company, the McMurdo Silver Company, has been opened by McMurdo Silver in Hartford, Conn. Activities will cover primarily production and sales of amateur parts, kits and special equipments, and consulting engineering.

Mr. Silver was formerly with Grenby Mfg. Co. as vice president in charge of radio and electronics.

* * *

DAVIS NAMED GALVIN AUTO RADIO CHIEF ENGINEER

Jack Davis has been appointed chief engineer of the auto radio division of the Galvin Manufacturing Corporation. Gus L. Mydlil has become assistant chief engineer.

BEN MILLER JOINS UTC AS S-M

Ben Miller has been appointed general sales manager of United Transformer Corporation, 150 Varick St., New York 13, N. Y. Samuel L. Baraf has taken over the merchandising activities as director of sales and merchandising.

Mr. Baraf will have complete charge of surveying present-day and potential industrial markets and planning for large scale distribution.

Mr. Miller was formerly with Meissner Mfg. Corp as sales manager.

S. L. Baraf Ben Miller

* * *

JFD ADAPTER MANUAL

A 16-page catalog, 340, listing tube adapters for octal, loktal, loktal metal base and resistor types, etc., has been published by J. F. D. Manufacturing Co., 4111 Ft. Hamilton Parkway, Brooklyn 19, N. Y.

Catalog also contains tube conversion data.

* * *

W. A. ONORATO NOW GEN. DRY BATTERY PRESIDENT

Walter A. Onorato has been elected president of General Dry Batteries, Inc., Cleveland, Ohio, and of General Dry Batteries of Canada, Ltd. He succeeds C. P. Diebel, founder of the company, who died in January.

Mr. Onorato had been vice-president in charge of the Gloversville, New York, plant and managing director of the Canadian company since 1934.

* * *

SPRAGUE PAPER CAPACITOR CATALOG

A 56-page illustrated catalog, 20, covering paper capacitors, has been issued by the Sprague Electric Company, North Adams, Mass.

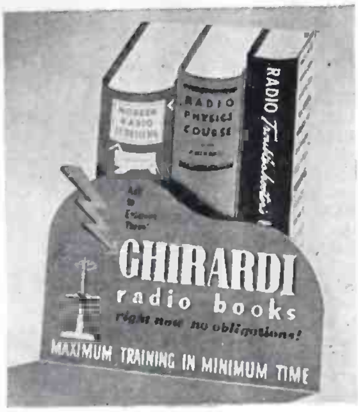
Included in the catalog are details and dimensions for Sprague cardboard and metal tubular types, bathtub types, large and small rectangular units, cylindrical container units, hermetically-sealed types, ignition capacitors, screw-mounted types, radio-interference suppression filters, do-t-shaped capacitors, 3-terminal network pes, fluorescent lamp capacitors, paper electric capacitors for a-c applications, c. Also included are details on Sprague ergy storage capacitors for welding, ash-photography, and similar uses; *vita-in Q* capacitors for high temperature es, including the hermetically sealed its in glass tubes; glass-to-metal seals r many types of capacitors and koolohm sistors.

* * *

GHIRARDI BOOK DISPLAY

A new series of store-counter and win-w displays advertising Ghirardi books now being offered free to radio jobbers Murray Hill Books, Inc., 232 Madison venue, New York 16, N. Y.

Display is 9¼" wide. It is reproduced five colors with an overall protective m of dust proof transparent varnish.



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MUTER COMPANY WINS E

The Muter Company, 1255 South Michigan Ave., Chicago, was recently awarded the Army-Navy "E." Les Muter accepted the pennant for the company. The "E" pins were presented by Lt. Col. Elden Koerner of the U. S. Signal Corps (at left in the photo). Others at the ceremony were (left to right in photo): Mr. Muter; Paul Pfohl, vice president; Col. Chester L. Fordney, U. S. M. C., and Commander Charles O. Triebel, U. S. N., who presented the "E" flag.

* * *

GENERAL CEMENT CATALOG

A 68-page booklet featuring data on dial belt-drive cable and cabinet repairs has been issued by the General Cement Manufacturing Company, Rockford, Illinois. Described are belt kits, cable racks, cables, drives, strippers, and alignment tools. An interchange chart is also offered.

* * *

DON MITCHELL NOW ON SYLVANIA BOARD

Don G. Mitchell, vice-president in charge of sales, Sylvania Electric Products, Inc., was elected recently to the board of trustees.

* * *

ELECTRO-VOICE CATALOG

A 36-page catalog, featuring a simplified reference level conversion chart for microphone rating standardization use, has been released by the Electro-Voice Corporation, 1239 South Bend Ave., South Bend 24, Indiana.

Poly-directional, dynamic, velocity and carbon microphones are described. Applications, specifications, diagrams, etc., are presented. Basic operating principles of microphones are also offered.

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FAREWELL BANQUET FOR FORMER AEROVOX OWNERS

At the head table of the farewell banquet, left to right: Sam Siegel, retiring vice president, and Mrs. Siegel; W. Myron Owen, new president; Mrs. Charles Golenpaul; S. I. Cole, retiring president; Charles Golenpaul, sales manager; Mrs. Emanuel Cohen, wife of Colonel Cohen, former stockholder and official of company; Stanley Green, new vice president and chief engineer; Frank Siegel, and Austin C. Lescarboura.

JOTS AND FLASHES

CONGRATULATIONS to Charley Golenpaul . . . just completing his 15th year as distributor s-m at Aerovox. . . . Harold Detrick appointed chief engineer home radio division of Bendix. . . . Astatic appoints Frank B. Russell, 5043 Marvine Rd., Drexel Hill, Pa., as sales rep. for District of Columbia and Virginia. . . . Recent press demonstration of Lear wire recorder for attachment to home radios a revelation. . . . John Meck Industries, Inc. move their Chicago office to 35 E. Wacker Drive under direction of Fred Arnold. . . . Tremendous radio *service* business due shortly after conclusion of hostilities . . . nation-wide surveys just completed by Sylvania and other manufacturers emphasize this fact. . . . Army-Navy "E" to Chicago and Richmond, Ind., plants of Belden Mfg. Co. . . . Frederick R. Lack elected to Western Electric board of directors. . . . New plant at Marietta, Ohio, to be opened by Sylvania Electric. . . . Times Appliance Co., Inc. to again distribute Westinghouse home receivers in New York City, Nassau, Suffolk and Westchester Counties. . . . Arizona Wholesale Supply Co., Phoenix, to distribute Hoffman line of radios. . . . Good tip for the future . . . buy all the 7th War Loan Bonds you can possibly handle.

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