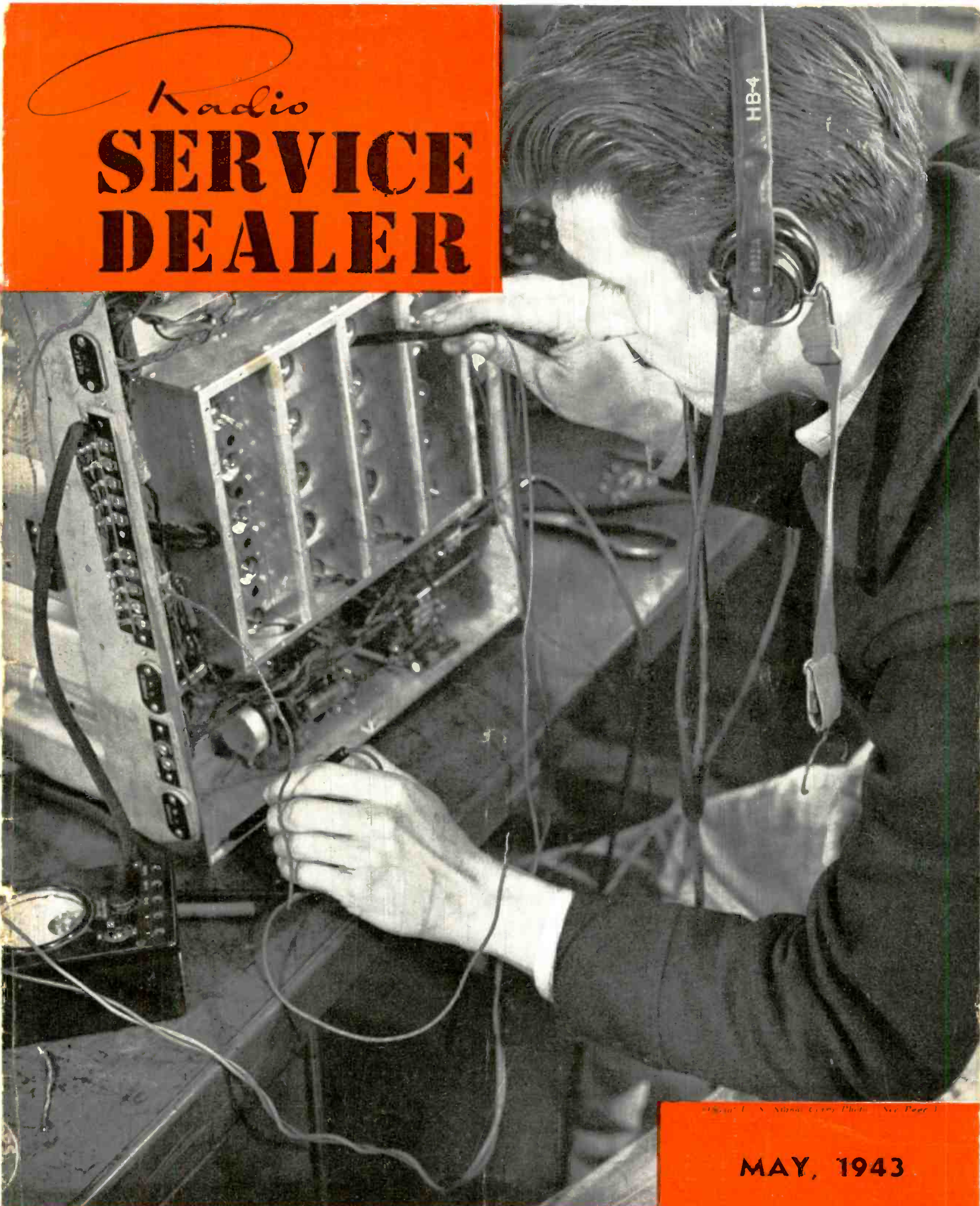
Radio

SERVICE DEALER



Official U. S. Signal Corps Photo—See Page [illegible]

MAY, 1943

RADIO-ELECTRONIC MAINTENANCE MEN

Radio
SERVICE-DEALER
SOUNDMAN AND JOBBER
Reg. U. S. Pat. Off.

Vol. 4, No. 5 ★ May, 1943

MEMBER AUDIT BUREAU OF CIRCULATIONS

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Ad Index

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Cover Picture

(OFFICIAL U. S. SIGNAL CORPS PHOTO)

Tom F. Smith, radio mechanic at the Signal Radio Repair Shop, Ft. Benning, Ga. repairs a receiver. The Signal Corps trains radio technicians in all phases of radio maintenance work. In post-war days such training will be invaluable. The high and ultra high frequencies to be used by home receivers will result in extremely complicated circuits.

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

Misleading Statements by WPB

• On March 31st WPB release No. 3008 was issued. In it Mr. Frank H. McIntosh, of the Radio Division, WPB, is credited with stating, *"In January sales by tube manufacturers for replacement purposes were almost 2,500,000"* and *"A Careful survey of the industry indicated that radio tube production, available for replacement purposes, is almost as high as in normal peacetime."* Then on April 15th WPB release No. 3183 was issued, and in it is the statement, *"WPB has kept production of radio tubes available for replacement in civilian sets almost as high is in peacetime."*

We read these obviously misleading releases, blew our top and gave the matter serious research. We learned that according to WPB concepts the statements aren't erroneous or misleading—but that is merely due to the peculiar manner in which WPB arrives at what they term "replacement tubes for civilian use." Let us explain! Down in Washington the War Production Board uses a very broad interpretation in regard to all radio tube production. As a general matter, WPB considers that all tubes made fall into either one of two classifications, to wit, (1) Tubes for Military Use or (2) Tubes For Jobbers and Civilian Replacement Use. So, if a jobber gets a high priority order for tubes from a Signal Corps Depot and he orders the tubes from a manufacturer, such tubes, according to WPB's present system, fall into the category of Tubes Delivered To Jobbers For Replacement In Civilian Sets. By the same token, if a war plant needs tubes, takes them from a jobber's shelf on high priority, and the jobber refills his stock—the act of refilling his stock (literally speaking) charges the tubes against deliveries made for civilian use. This is the most "peculiar" manner of classifying tube distribution WPB could conceive, to our mind.

If Joe Doaks, the barber, has a set that needs tubes and the service-dealer orders them from a jobber, the latter, by means of PD-1X rates his order at A-1-j and places it with a tube manufacturer. Tube manufacturers have made practically no deliveries on such low-rated orders, what with the materials shortage. Yet, if a tube maker did fill this particular order, WPB's books would list this as a delivery to jobbers of civilian tubes, and that is what it should be, IF it could happen.

Now that you understand WPB's method of classifying tube deliveries you can assume that their releases weren't exactly erroneous. We submit that they were and are misleading to fellows like us in the radio maintenance field and undoubtedly they give a very wrong opinion as to the status of tube deliveries to Mr. Averageman who owns a set and needs replacement tubes which are practically impossible to obtain. But let's carry the discussion further.

Actual examination of jobbers' records indicate that over 80% of all tubes received by them from tube manufacturers since January 1st, 1943, were purchased on high priorities as they were destined for military agencies and war industries who could furnish high priorities. Furthermore, leading tube manufacturers concur that their records also indicate that 80% of the tubes produced and delivered to jobbers were based on high priorities and obviously were not intended for ultimate use in civilian owned receivers. So, had WPB been explicit their publicity releases would have been worded somewhat in this manner, "Of the 2,500,000 tubes delivered to jobbers by manufacturers approximately 500,000 were potentially for use in civilian owned sets as replacements while the 2,000,000 balance were ostensibly made for some military agency who had a high priority status.

The Certification Plan

• Mr. McIntosh addressed the NAB's convention in Chicago on April 26th and reiterated that the tube shortage is due to maldistribution primarily although he did admit that the Army and Navy have raided dealers' and jobbers' stocks at various times. That's putting it mildly! His further observation that the new Certification Plan promises to make for fairly complete stocks of tubes for civilian use is, in light of developments, rather optimistic. There can be no possible accumulation of tubes for specific civilian use under any present WPB setup. The only possible way to get tubes to jobbers for resale to civilians exclusively is by having WPB definitely establish and provide allocations of needed materials so that tube makers can produce the tubes in question. Under any other system the Army, Navy or possessor of a high priority can commandeer tubes on a dealer's or jobber's shelf. The Certification Plan does not require a priority issuer to turn in an old tube for a new one, but it does require civilians to do just that.

Undoubtedly Mr. McIntosh is trying to solve his dilemma. He probably wants to provide tubes for civilian radio sets, subordinating such tube production to Military needs, as is only just and proper. The war effort must come first, we all agree. So far all means of accomplishing his end have eluded our Washington champion. Allocations is the answer! But, by the time he gets allocations, we fear tube production facilities will be unavailable.

We Change Format

• The next and subsequent issues of RADIO SERVICE-DEALER will for the duration, be trimmed to an over-all size of 8⅛ by 11¼ inches which represent the NIAA recommendations to conserve paper. This means that "RSD" will hereafter have a smaller margin of white space around all pages.

Inoperative Receivers

• Estimates vary as to the number of receivers now lying idle because of tube and parts shortages. Service-dealers tell of vast numbers being out of use while WPB and NAB believes the number is negligible. What is your opinion based upon your actual records? In rural areas the situation must be very acute for even WPB admits steps have been taken to provide batteries around January 1, 1944.

TUBE SUBSTITUTIONS

By John H. Potts

Once again Mr. Potts goes into the tube substitution-circuit revision problem. Here he discourses on tubes not previously covered.

DWINDLING supplies of most types of tubes available for civilian use make the problem of obtaining replacements increasingly difficult. It is becoming more and more necessary to substitute other types for the hard-to-get tubes, even though it may be essential in some instances to make modifications in the receiver to accommodate the substitution. From time to time we have published data on tube substitutions, together with a chart giving the information in tabulated form for ready reference. Much new data have become available since this chart was last published, in October, 1942, and accordingly a revised edition is reproduced in this issue.

It will be good news to many to learn that suitable substitutes for the 6AC7 and 6AB7 have now been worked out. These two types have been among the toughest of all to obtain commercially and likewise hard to replace with substitutes. The mutual conductance of these types is far above that of other tubes of similar classification, as normally used, consequently such substitutions as have been suggested have resulted in lower stage gain because of the reduced mutual conductance of the substitute. This has been evident when the 6SK7 or 6SJ7 have been used. The high gain of the 6AC7 is most often employed in connection with FM receivers, where the overall performance is vitally dependent upon an excess of amplification. Thus owners of such receivers have been obliged either to let their receivers remain inoperative, or put up with less than normal high-grade performance when such tube substitutes are employed.

The recommended substitution is the 7V7 or 7W7. These local types are somewhat similar except for the socket connections. The cathode of the 7W7 is brought out to the #4 and #7 pins while on the 7V7 only a single cathode connection, to the #7 pin, is supplied. The internal shield connection of the 7V7 is joined to pin #5, but this connection is omitted on the 7W7, the suppressor connecting to #5 instead. As normally used, the mutual conductance at rated operating voltages is 5800 micromhos, with the usual 160-ohm cathode bias resistor. When compared with the 6AC7 with its mutual conductance of 9000 under the same operating conditions, this value of 5800 micromhos seems low. But, according to Sylvania News, if the suppressor grid of the 7V7 is tied to the screen, a 250-volt plate supply and 135 volts screen supply are employed, the mutual conductance will be increased to 8000, when the control grid bias is —2 volts. This closely approximates the nominal rating of the 6AC7 and should work out much better than previously used substitutes. The 7W7 may be similarly used, but an external shield is recommended.

Customer—"I want tubes that are guaranteed not to burn out."

Dealer—"I'm not so fussy, Brother, I'll take any kind I can get!"

The 6SG7 and 6SH7 are 0.3 amp. filament current tubes of high mutual conductance. Where the 0.45 amp. drain of the 7V7 or 7W7 is not prohibitive, Sylvania recommends the substitution. The required mutual conductance of 4700 is achieved by operating the screen of the 7V7 (or 7W7) from a 300-volt supply through a 100,000-ohm series resistor. The control grid bias should be —1.5 volts. If a cathode resistor is employed, the value will have to be increased to approximately 200 ohms, because the plate and screen currents of the 7V7 or 7W7 under these operating conditions will total only about 7.7 ma.

The 14W7 is the 12.6-volt edition of the 7W7 and these two types are interchangeable, except for filament voltage. And the 7V7, of course, is likewise interchangeable with the 14W7, provided the necessary changes in socket connections are made along with the filament voltage.

The duo-triode XgD is the same as the 14F7, which in turn harks back to the 7F7, except for filament voltage. This tube contains two high-mu triodes and is useful for phase inverter purposes. It may be substituted for the 6C8G, 6F8G or 6SN7-GT. In each case greater gain will be obtained with the substitute, because of the higher amplification factor thus obtained. The amplification factor is 70 in the case of the 7F7, which compares with 36, the value for the 6C8G and 20 for the 6F8G and 6SN7-GT. This should be remembered when a little additional "hop" is needed to boost gain lost in other substitutions. This change is best made when the tube for which the 7F7 is being substituted is a phase inverter. The 7F7 also fits in nicely as a replacement for the 6SC7, having the same amplification factor in each triode section. The principal difference between these two types, other than the socket and socket connections, is that the 7F7 has two cathodes while the 6SC7 has but one.

The XXFM and the XXL find their equivalents in the 6R7G (except for socket) and the 7A4, respectively. The former is a duo-diode low-mu triode and the latter is similar to the 6J5G, except for the socket and a slight difference in mutual conductance and plate current, both of which are somewhat higher in the 6J5G.

The 25L6GT is becoming a hard-to-get type. There is no precise equivalent for this tube, but the 35A5 and 50A5 can be juggled with to provide an approximation. These two substitutes require a slightly higher filament voltage, as is apparent, which can be obtained by lowering the line cord resistance, if necessary. In many cases, direct substitution can be made, particularly if there are several tubes in the filament string, so that the resulting drop in current is distributed along the line. The output of the 35A5 at rated filament voltage is 1.5 watts as compared with 2.2 for the 25L6. The 50A5, at rated filament voltage, does the trick nicely, giving the same power output as the 25L6, but will require adjustment of the line cord resistance to make up for the increased voltage drop.

While the 25C6G can be used as a substitute for the 25L6G, the bulb is larger, which may be a limiting factor in many receivers of the midget type. Further, the bias voltages of the 25C6G would have to be altered, by adjustment of the cathode resistor, to approximate the output of the 25L6G. In many of the cheaper sets, however, it should be possible to make a direct substitution without any monkeying around, and still get a pretty fair approximation of original performance. The 50-volt edition of the 25C6G—the 50C6G—may also be used by making the necessary adaptations for the difference in filament voltage.

While substituting a 25B6G for a 25L6G would result in a loss of power output because of the difference in power sensitivity of the pentode and beam power tetrode types, we mustn't forget that substitutions the other way around would produce a corresponding improvement in performance. Thus, for the 25B6G, any of the substitutes for the 25L6G, mentioned above, are more than welcome.

Another of the beam-power type tubes which is getting scarce is the 7A5. This is similar to the 35A5, except for filament current and heater voltage. The high current (0.7 amp.) makes necessary changes in the heater supply to provide the proper voltage and current when suitable substitutes are employed. If the 35A5 can be had, making these changes should provide identical results. On the other hand, if the 25L6 is available, the substitution of an octal for the loctal socket will be required in addition to the changes in heater current and filament voltage. These changes are well worthwhile, however, because, from a performance standpoint, the 25L6 provides somewhat higher power output at 110 volts at the cost of somewhat greater distortion. The ratings are identical at 125 volts.

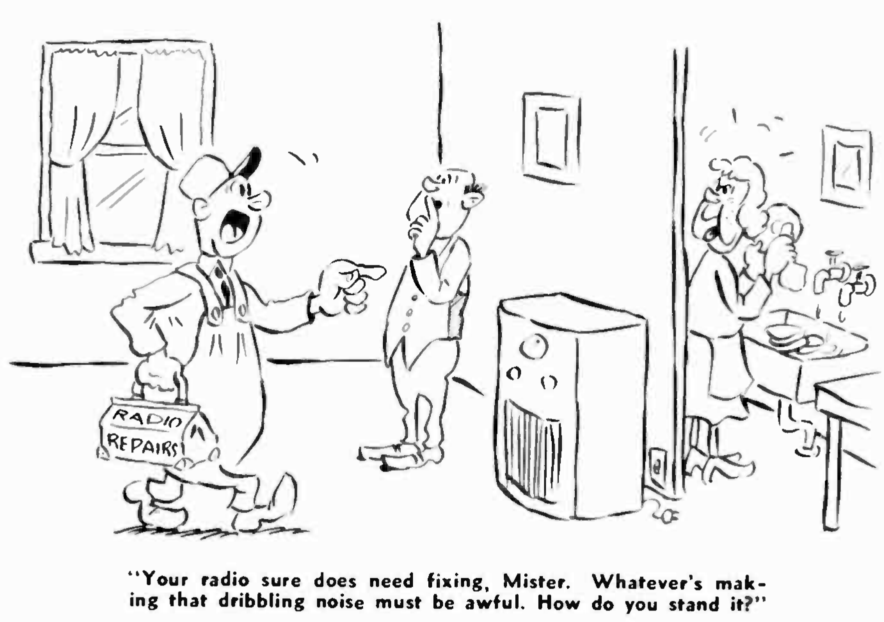
The 7B5 is the loctal equivalent of the 6K6G and these tubes may be used interchangeably provided the sockets are likewise changed. Like other power amplifier pentodes, such as the 6F6, they are inefficient at the low operating voltages found in ac-dc receivers, and beam power types should be substituted whenever possible, for maximum efficiency under such operating conditions. However, it must be remembered that the beam-power tubes also require greater plate current, so make sure that the output transformer is suitable when such a tube substitution is under consideration.

The big demand for 6SK7GT/G's runs many stores short of this type. If you can dig up the corresponding loctal — the 7A7 — and change the sockets, you will be able to put back into operation many sets which otherwise might lie idle. Alternatively, the 7B7 may be used as a substitute—not quite as good, though, because its lower heater current cuts down its mutual conductance about 15% less than the 6SK7GT/G. The 7B7 is really the equivalent of the 6S7G, except for the socket.

Among the pentagrid converters, the very popular 6A8GT can be replaced by the loctal equivalent, the 7B8. And the single-ended 6SA7GT finds its counterpart in the loctal 7Q7. Duo-diode-triodes are found in almost all modern receivers, and if you run out of 6SQ7GT's, remember, that the 7B6 is the same, except for the socket. If the set at hand has a 6H6 rectifier, feeding a 6F5GT, it is always possible to use the 7B4 loctal equivalent of the 6F5GT.

Among the smaller battery-operated tubes, it is good to remember that an "L" following the first num-

(Continued on page 32. See Tube Substitution Chart, page 31)



"Your radio sure does need fixing, Mister. Whatever's making that dribbling noise must be awful. How do you stand it?"

The SPRAGUE TRADING POST

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OFFERED — Superior Meg-O-Meter; two scales 50,000 ohms to 5 Meg., and 2 Meg. to 100 Meg.; good condition, with batteries and leads. Will sell for cash, or exchange for what have you? O. H. Grinnell, 927 9th St., Monroe, Wis.

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WANTED—Jewell 199—444 analyzers. Must be in working condition, not burned out. Will also pay cash for Weston or Supreme instruments. Send price and full details. J. D. Kennedy, Box 86, Stanhope, N. J.

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EQUIPMENT FOR SALE—Will sell Supreme Model 562 Audelyzer slightly used, price $100. E. R. King, Signal Section, Mobile Air Depot, Mobile, Ala.

WANTED—Will pay cash for 2" or 3" oscilloscope (must include tubes); Meissner or Rider analyst; and Vols. 7 to 12 Rider's Manuals. I also have for sale, or as partial payment on above: Superior Channel Analyzer; Superior dynamometer (VOM and VTVM); and various new dynamic speakers including some PM's, also some audio, power, and output transformers, etc. John Archibald, 1722 Melville St., Bronx, New York.

WANTED—A good make service oscillator and an output meter. Harry E. Slates, 232 South 8th St., Steubenville, Ohio.

FOR SALE OR TRADE—Parmak 6V. 20A. Windcharger; Hickok AC 49 tube tester (tests octals); Jewel 562 battery-operated RF oscillator. Would like to get tubes (especially 1½V. and 12V. types): service manuals; repair parts: small radios; and 16mm. projector, silent or sound. Hasco Radio Service, Myrtle Creek, Oregon.

SWAP OR SELL—Dunco low and high current relays; Clough-Brengle 3" oscillograph; Ferranti transformers, A & B series; and 3 Sangamo hour counters and other items. Write for details. Want VTVOM chanalyst or equivalent, and a-f oscillator. Julius J. Bressler, 25 Dongan Place, New York, N. Y.

WANTED AT ONCE—One portable volt-ohm-milliammeter; also late model tube tester. Must be in good condition. Give make and describe. J. W. McCracken, 841 Carondeley, New Orleans, La.

SERVICE STOCK FOR SALE — Have joined Signal Corps as radio instructor and offer varied stock of parts and eqpt. for immediate sale. Must sell quickly. Stock includes brand new C-D capacitor bridge with tube, .00001 to 50 mfds; Triplett ohmmeter 0 to 10 megs.; a B eliminator, gives 185 volts; a 6-8 volt DC motor generator; dial lites; metal tubes; resistors, condensers, volume controls—in fact, almost anything you might want. Write for details. Name what you need. E. O. Cole, R.E., 4714 W. Erie St., Chicago, Ill.

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WANTED—Tubes. Dumont Nos. 889, 128M, 913. Television receiver or complete kit. Back number radio magazines to swap. Larry Otis, 628 Firestone Blvd., Norwalk, Calif.

WANTED—Sprague Tel-O-Mike or other condenser checker; Radio 'phone recorder comb.; recorder unit cutter and motor; Hallicrafter S-20R; 6C8-6J7-68J7 tubes, new or used; Thord. tone cont. choke T14C70. Have 'phone amps., parts, etc. Cash or trade. What do you need? C. J. Seymour, 3110 Division St., Los Angeles, Calif.

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

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FOR SALE—Weston-Jewell model 444 two-meter analyzer, $35; Weston-Jewell model 562 test oscillator, $30; Rider's Volumes 1 and 2, $7. All practically new. Max Strauss, 11118 Clifton Blvd., Cleveland, Ohio.

WANTED URGENTLY — 4½" fan-shaped 0-1 Ma. meter; cash. Will sell or swap 1 HY40, 3 T55 transmitting tubes. Spears Radio Service, 901 So. Fort Harrison Ave., Clearwater, Florida.

TUBES OFFERED—Wide assortment of tubes in original cartons; also good used tubes and parts for many make sets—converters, motors, etc. Want 12SA7—12SK7—50L6—Oscilloscope; Rider's Manuals. Stephenson', 1307 H. St., N.W., Washington, D. C.

WANTED—New or used table model ac or ac-dc radios; also batteries and 3525 tubes. What have you? Will pay cash or trade some tubes. Lee Amusement Co., L. & H. Radio Co., Shellman, Ga.

RIDER'S MANUALS WANTED—Volumes 1 to 12. State price and condition. John R. Westberg, R.D. No. 1, Box 81, Laveen, Arizona.

METERS TO SELL OR SWAP—Supreme model 90 ac-dc analyzer and model 19 tube checker; Jewell model 85 dc analyzer and 0-3-15-150 ac VM, excellent for panel board. All meters, shunts, multipliers in A-1 condition. Need Precision Apparatus E-200 signal generator. What do you offer? Roberte Blackmar, 991 Sacket Ave., New York, N. Y.

TUBES WANTED—50L6, 35L6, 3526, 12SA7 and 12SQ7. Will pay full list prices, or send list of tubes needed so we can exchange. Granger Radio Service, 62 Spring St., Rochester, N. Y.

WILL EXCHANGE — Earphones and code keys (3 of each) for 0 to 1 mil. or 3525 tubes, or what have you? Weir Cove Radio Service, 508 Garden Way, Weir Cove, W. Va.

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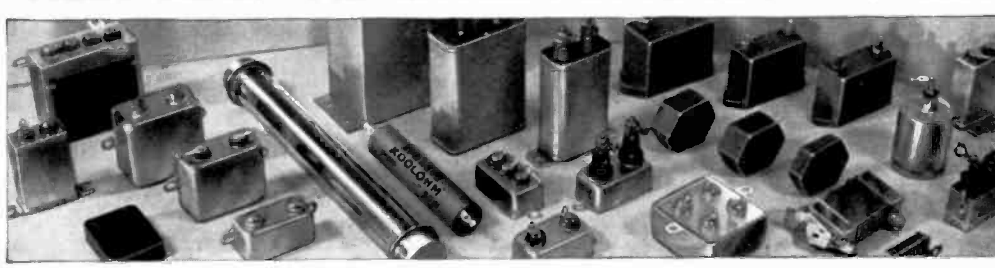

Here are some of the Sprague Condenser and Koolohm Resistor types being supplied in tremendous quantities for war requirements. Many of these represent outstanding engineering achievements which will be reflected in Sprague radio service and industrial components for post war needs.

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North Adams, Mass.

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

THE USE OF OSCILLOSCOPES

PART 2—by Oscar E. Carlson

As stated in Part I of this series of articles, "The function of an oscilloscope is to act as an instantaneous voltmeter over a period of time so arranged that the instantaneous values of voltage over that time may be graphically portrayed and observed on the screen of the cathode ray tube." Varying voltages applied to the deflection plates of the CR tube, either directly or through the amplifiers, result in a pattern dependent upon the wave forms of the applied voltages, their frequencies, and phase relationships.

The resulting patterns are termed Lissajou's Figures. They are well treated in many textbooks and will be treated here only as they coincide with the uses described.

Many servicemen and technicians fail to use oscilloscopes for the very elementary reason that they never bothered to acquire a working knowledge of the 'scope's uses and the theory involved. Most servicemen will agree that a definite practice has been to assume that "if it sounds OK, it is good enough." This thought was perfectly natural some years ago before the advent of high fidelity receivers, frequency modulation, and television. However, with a large portion of modern communication equipment the use of an Oscilloscope is imperative for rapid trouble-shooting and proper alignment and adjustment.

The cathode ray tube has found many uses other than in the Oscilloscope. Some of these modern uses that the serviceman and radio technician must eventually familiarize themselves with are:

1. *Panoramic Reception*
2. *Ionosphere Measurements*
3. *Direction Finding*
4. *Absolute Altimeters*

and innumerable others. The understanding of the theory and uses of a conventional Oscilloscope will not only aid in ordinary radio work but will provide a basis for knowledge of the workings of the above mentioned associated cathode ray equipment.

Oscilliscope Characteristics

The average oscilloscope has vertical amplifier response fairly flat from about 10 cycles per second to 100,000 cycles-per-second. The horizontal amplifiers usually have a somewhat lower high frequency response because of the fact that the phenomenon to be observed is usually impressed across the vertical plates through the vertical amplifier. The sweep frequency is usually variable from about 5 cycles-per-second to a maximum of 25,000 cycles-per-second. The chart, *Fig. 1*, shows the characteristics of several popular Oscilloscopes. Included in this chart are three units with very wide band vertical amplifiers. Such units are at present limited to laboratory and industrial use. Such wide band units are far superior to the average oscilloscope for some

Fig. 1

OSCILLOSCOPE DATA CHART

Manufacturer & Model	Frequency Response of Amplifiers	Sweep Frequency	Amplifier Gain	Cathode Ray Tube Diameter
Dumont Type 208	Ver: 2 to 100,000 c.p.s. Hor: 2 to 100,00 c.p.s.	2 to 50,000 c.p.s.	Ver: 200X Hor: 43X	5"
Dumont Type 164E	Ver: 7.5 to 100,000 c.p.s. Hor: 7.5 to 100,000 c.p.s.	15 to 30,000 c.p.s.	Ver: 50X Hor. 40X	3"
Supreme 546	Ver: & Hor: 15 to 90,000 c.p.s.	15 to 30,000 c.p.s.		3"
RCA 158D	Ver: 5 to 500,000 c.p.s. Hor: 5 to 100,000 c.p.s.	4 to 22,000 c.p.s.		5"
RCA 155A	Ver: & Hor: 20 to 90,000 c.p.s.	15 to 22,000 c.p.s.	Ver: & Hor: 100X	3"
Dumont 224	Ver: 20 c.p.s. to 2 Mc. Hor: 10 c.p.s. to 100 Kc.	15 to 30,000 c.p.s.		3"
RCA 305B	Ver: & Hor: 5 c.p.s. to 10 Mc.	5 c.p.s. to 100 Kc.		9"
Dumont 223	Ver: & Hor: 2 to 75,000 c.p.s.	8 to 30,000 c.p.s.		20"
RCA TMV-122B	Ver: & Hor: 20 to 90,000 c.p.s.	20 to 15,000 c.p.s.	Ver: & Hor: Approx. 40X	3"
Radio City Products Co., Inc. 555	Ver: & Hor: 20 c.p.s. to 2 Mc.	45 c.p.s. to 750 Kc.		5"

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Maybe you've never tried a slice of delicious cake, home-baked to perfection by Radiothermics. *But you may!*

Maybe you've yet to see bread baked inside out (with the crust on the inside, if that's where you want it) by this same amazing method. *But you may!*

Or, perhaps, you haven't been around busy industrial plants where heating, drying, case-hardening, and similar jobs which formerly took hours by conventional methods are now being done better and, frequently, *in minutes* the Radiothermic Way.

Distributing, installing, and maintaining equipment for such purposes may well be a part of the job of the busy "Radio" man of the future. Classify these new developments under whatever general heading you will, they all add up to expanding opportunities for you.

All of these developments use Electron Tubes as their "Magic Brain." Just as RCA Tubes helped to make Radio what it is today, so will they contribute to this vast related industry of tomorrow.

"Electrons in Action at RCA"—BOOKLET FREE!

Did you know that modern RCA Tubes could not be precision-made in quantity without employing equally modern tubes in the operations used in their manufacture? This profusely illustrated 32-page book tells the story of electrons in action at RCA, and contains many valuable pointers on possible electron tube applications in other fields. Copy gladly sent on request. Ask for Booklet No. 1F8159.

RCA

RCA RADIO-ELECTRON TUBES

RCA Victor Division, **RADIO CORPORATION OF AMERICA,** Camden, N. J.

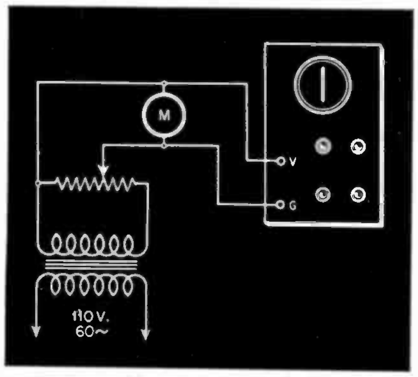

Fig. 2. Circuit for calibrating the vertical Oscilloscope Amplifier.

types of specialized work but offer little advantage in the work of the serviceman.

In using an oscilloscope with a vertical amplifier flat to about 100,000 cycles-per-second, and having a sweep frequency of 25,000 cycles-per-second, we can view as few as four cycles of a 100 kilocycle input wave.

Applications

Most applications of the cathode ray oscilloscope are so arranged that the output of the unit under test is connected to the vertical plates of the cathode ray tube. The waveform to be studied is viewed, or observed, by applying known constants on the horizontal plates of the cathode ray tube.

One of the most practical uses of the oscilloscope is as an electronic alternating current voltmeter. Many service shops having an oscilloscope but no vacuum tube voltmeter can calibrate their oscilloscope so that it may be used as a very satisfactory ac vacuum tube voltmeter. For the measurement of ac voltages the scope may be easily calibrated for all frequencies within the flat portion of its response curve as follows. Use the setup as shown in *Fig. 2*. Set the vertical gain control of the oscilloscope at maximum and the attenuator taps at no attenuation. With the potentiometer set for some low voltage, say 1 volt, adjust the vertical centering control so that the straight line trace is adjusted to have its bottom on the center axis of the graph facing of the 'scope. If the 'scope has no celluloid graph face, measure the line length. Either count the graph divisions or measure the line length for that low voltage and for several other higher voltages up to the voltage at which the trace becomes too long for the screen. Then increase the attenuation to some definite point and repeat for a higher range of voltages. *The line length will represent twice the peak ac voltage, but since the input was measured in r.m.s. values, the calibration will also be for r.m.s. volts input.* A typical family of calibration curves as made by the writer for an RCA TMV-122B oscilloscope appears in *Fig. 3*. These curves are for three settings of the attenuator and are from a fraction of a volt to 15 volts. Any ac input beyond this value should be impressed directly on the vertical plates and a calibration curve made the same as described above.

Such calibration curves hold very accurately over the flat frequency response range of the amplifier. A frequency check on the vertical amplifier of the RCA TMV-122B oscilloscope resulted in the solid line curve of *Fig. 4*. Over any range of frequencies beyond the unity response range we would then multiply the value received from the calibration curve of *Fig. 3* by a factor obtained by dividing the response at that frequency into unity. At 250 kc. the response is .5 and we would multiply the value read from *Fig. 3* by 2 when measuring an ac voltage of that frequency. At 1000 kc. the response is .15. Our multiplying factor would then be 6.7.

"Sometimes it spells naughty words!"

Checks made on the RCA 158D by the writer show it to have a frequency response equivalent to the dotted line curve shown in *Fig. 4*. The response of this unit holds to 70% out to 700 kc.

Fig. 5 shows two typical calibration curves for two attenuator settings of the RCA 158D oscilloscope. It was found here that the change from tap 2 to tap 3 resulted in an attenuation of exactly five times. For measurements up to about 3 megacycles we may use the same method as described for the TMV-122B. These measurements were made by the writer with the only two oscilloscopes at his disposal. The methods hold for any model or manufacturer, but of course each 'scope must be separately calibrated. The flat frequency response range may be taken from the manufacturer's specifications and is usually slightly better than stated.

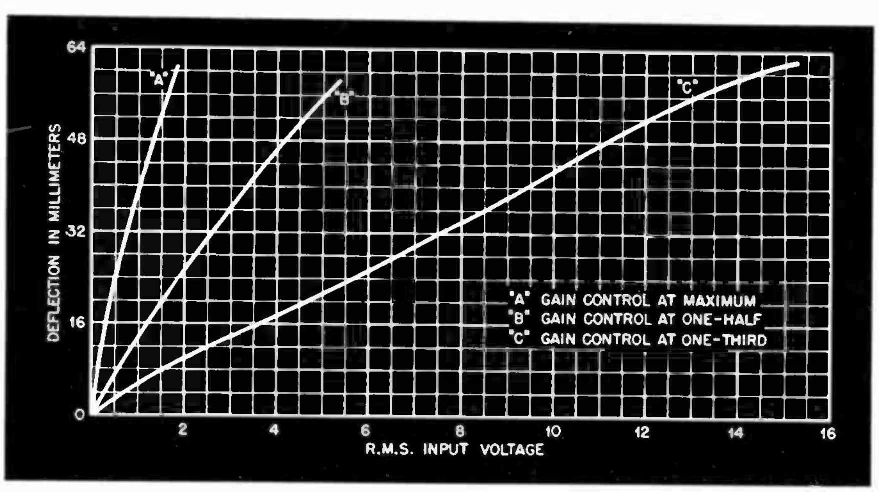

Fig. 3. Typical calibration curves for RCA T.M.V.-122B

Frequency Measurements

The next important use of the oscilloscope that we shall treat is that of frequency measurements by the *comparison method*. You will remember, from paragraph one, that the patterns on a cathode ray tube are dependent in part upon the frequency relationship of the voltages applied to the vertical and horizontal plates. Two voltages of equal frequency but of some phase difference other than zero degrees or 180

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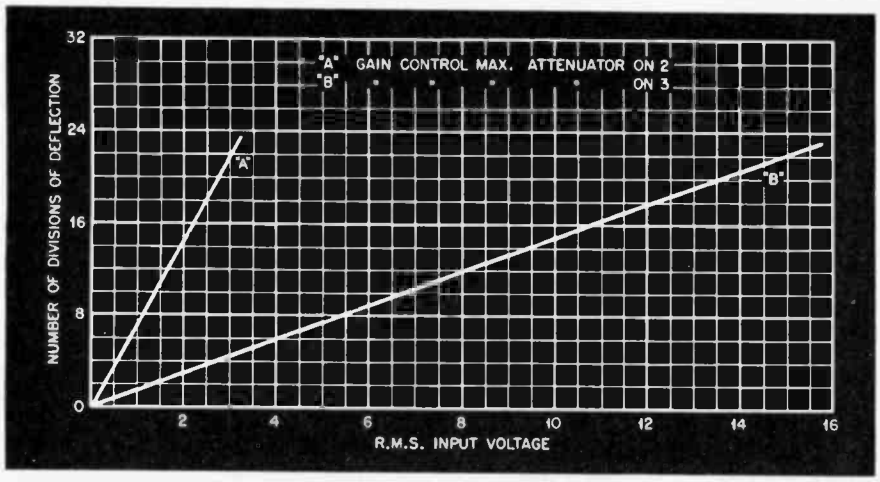

Fig. 5. Typical calibration for RCA 158D vertical amplifier for use as V.T.V.M.

degrees, will when impressed on opposite sets of deflection plates on an oscilloscope cause a resultant pattern which will vary from a very narrow ellipse to a full circle. The pattern will lean in a direction determined by the phase relationship. At 0 degrees or 180 degrees for a 2 to 1 frequency ratio the resulting pattern will be an half ellipse open either to the left or to the right dependent upon the phase relationship. For all other phase relationships the resultant pattern will be a figure eight whose open width and direction is dependent on the phase. The various patterns are as shown in *Fig. 6* for five phase relationships.

A frequency ratio of 3 to 1 will result in three joined cycles. A 4 to 1 ratio results in four joined cycles. The frequency ratio will always be equal to the number of joined cycles. It is necessary therefore only to count the number of peaks on either side of the pattern and the frequency ratio is obtained. By applying a known frequency voltage to one set of plates and the unknown frequency to the other set we may multiply the ratio by the known frequency, if the unknown is higher, and find the unknown frequency. Such a method is usually quite easily used up to at least a ratio of 10 to 1. Typical patterns for several ratios are shown in *Fig. 7*.

A method more applicable to frequency measurements of ratios greater than 10 to 1 is by means of a circular sweep. The circular sweep may be caused by placing two signals, identical in frequency but having a 90 degree phase difference, on the opposing sets of deflection plates of the 'scope.

The voltage for the circular sweep may be taken from the 60 cycle line through a step down transformer as shown in *Fig. 8*. This also provides a known frequency against which to check the unknown. Having arranged the components as shown for a circular sweep it is necessary only to impress the unknown frequency across the vertical plates through the amplifier. The circular sweep will then be distorted into a circular pattern whose circumference will vary sinusoidally as the applied unknown frequency. The number of complete cycles making up the closed pattern will be the frequency ratio of the unknown to the known. *Fig. 8* shows such a pattern for a ratio of 14 to 1. If the circular sweep were 60 cycles-per-second, the unknown frequency would then be 14 x 60, or 840 cycles.

A.C. Current Measurements

It is often desired for laboratory and experimental work to measure small alternating currents. Few servicemen possess alternating current milliameters or ammeters. The oscilloscope can be readily used to measure ac current values in circuits having high impedance components. As is quite apparent, the voltage

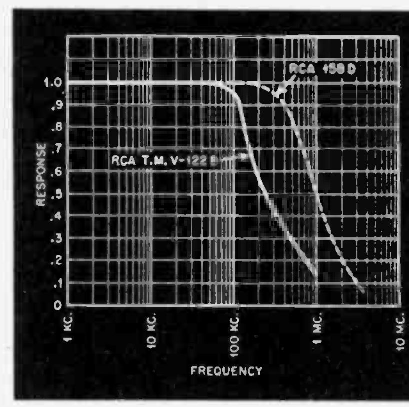

Fig. 4. Frequency response of vertical amplifiers in RCA 158D & RCA T.M.V.-122B.

drop across a 1000-ohm resistor gives the numerical value of the current flowing in milliamperes. By the use of a voltage calibration chart as shown in *Figures 3* and *5* it is possible to measure ac current as follows.

Insert a 1000-ohm resistor in series with the high impedance circuit element. Connect the vertical amplifier input connections of the oscilloscope across this resistor. With all controls set for voltage measurements, note the deflection on the 'scope and check that on the calibration curve. The voltage value giving that deflection will then be the numerical value of miliamperes of ac current flowing in that circuit. *Fig. 9* shows such a set up. Smaller values of resistance may be used to measure larger current values on the same voltage calibration curve.

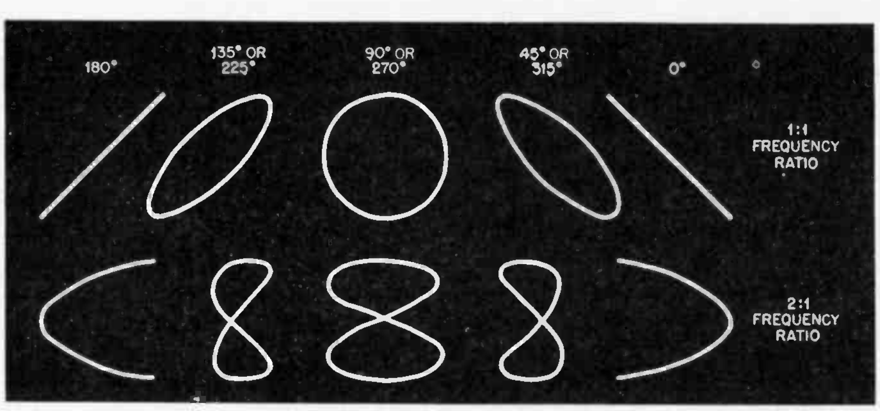

Fig. 6. The various patterns for five phase relationships.

Receiver Output Waveforms

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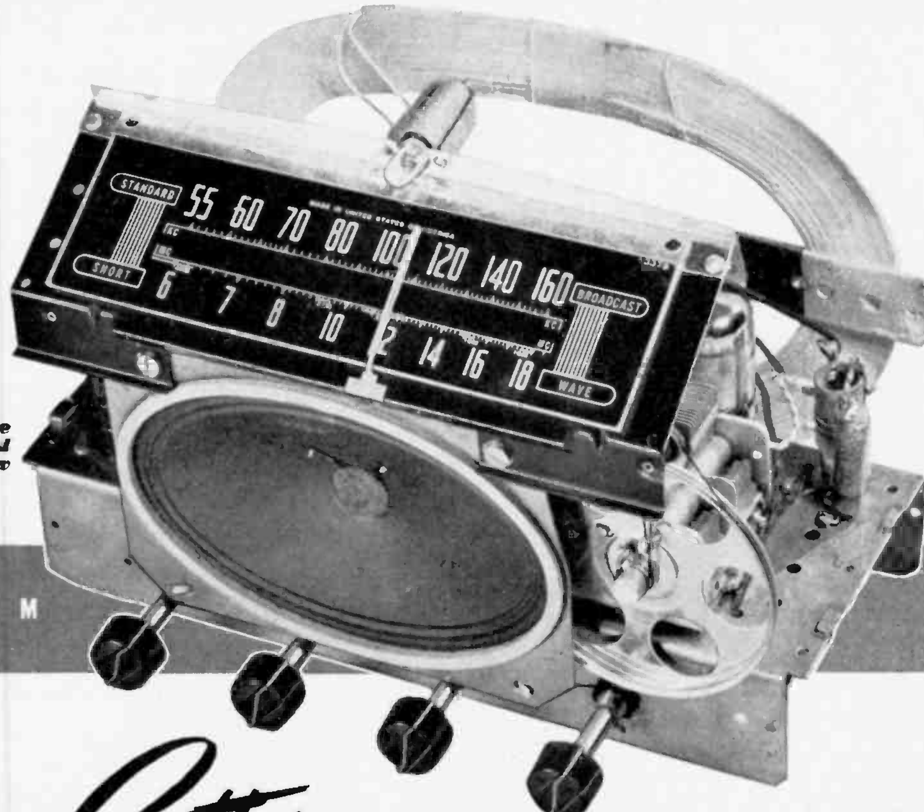

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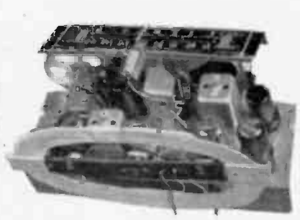

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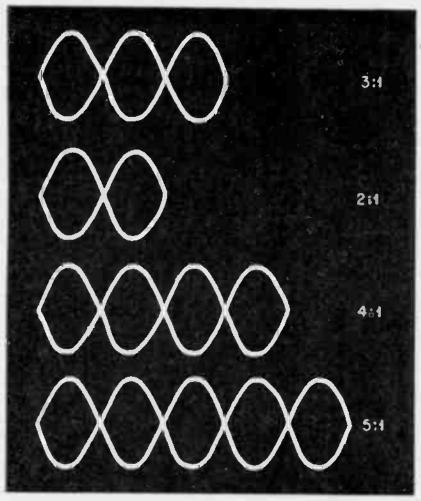

Fig. 7. Typical ratio patterns.

ceiver output voltage, an rf signal modulated with an audio sine wave is fed into the receiver input and the output voltage across the secondary of the output transformer is impressed across the input of the vertical amplifier of the oscilloscope. The signal is then reproduced on the CR tube screen when a suitable sweep frequency is used to move the electron stream horizontally across the screen. Deviations from a sine wave are easily detected and located by stage to stage signal injection, or by r-f i-f, and audio input frequencies being used so that each portion of the receiver may be separately checked.

By using a signal generator giving a constant r-f output and fixed percentage of modulation for a number of audio frequencies, an overall fidelity check may be obtained. The height of the defection should be noted for the full range of frequencies used. The response will then be as the deviations noted in the height of the deflections over the range of frequencies when the input voltage and percentage of modulation were held constant.

If the signal seen on the screen has harmonics so that it is distorted from a sinusoidal form it will show up as seen in *Fig. 10*. Overloading and distortion in the output will show up as a pattern containing harmonic frequencies not present in the input voltage from the signal generator. A pattern of this type while indicating distortion does not necessarily mean that it is caused by overloading. Impedance mismatch will cause the same result.

I-F Alignment

To align the intermediate frequency amplifier of a superheterodyne receiver using the 'scope as the indicating device we need in addition to the 'scope an external signal generator having provision for external sweep; the external sweep unit, or modulator. This unit is sometimes called a "wobbulator" and should be able to vary our signal generator frequency plus or minus about 15 kilocycles so as to cover the response frequency of the intermediate frequency amplifier stages.

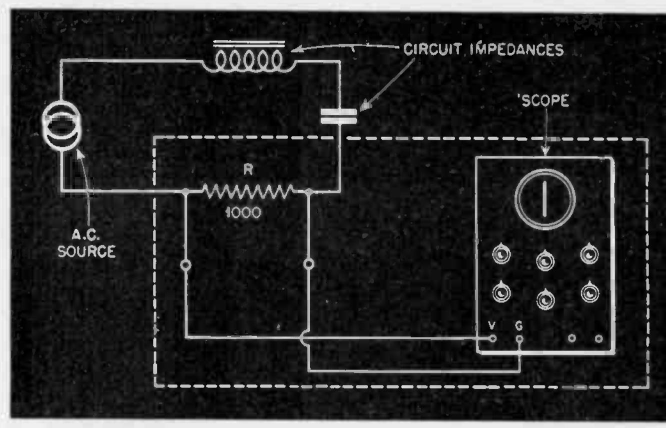

Fig. 9. Setup for using oscilloscope as AC Milliammeter. A typical circuit in which such a check would be made is also shown.

The oscilloscope is connected to the second detector output, and the frequency modulated intermediate frequency signal to the grid of the last i-f tube. The last i-f transformer is then peaked so that the center i-f frequency will fall midway on the overall response curve which will appear on the oscilloscope screen when a horizontal sweep voltage of proper frequency is used. The form of the curve is much as shown in *Fig. 11*. Those curves being typical of wide band i-f stages providing uniform response over a wide band of frequencies. This is repeated for each stage working back toward the first i-f stage and that is adjusted by coupling the output of the frequency modulated signal generator to the grid of the convertor tube.

The reason for the cathode ray tube trace giving the response curve as shown in *Fig. 11* is relatively simple. The voltage output of the second detector is pulsating dc and when that is impressed on the vertical scope amplifier the trace will at any instant of time be deflected upward by an amount in proportion to the rectified signal at that time. The time base of the 'scope is now representative of frequency so that at a definite point of time a certain frequency is being detected. The maximum voltage will be developed by the detector when the frequency is at the center i-f frequency for a critically coupled circuit. For an over coupled circuit the maximum response will be noted at two positions. The two positions will be at plus and minus the center i-f frequency. Overcoupling produces an essentially flat response curve. The amount of dip at the center frequency is dependent upon the amount of overcoupling employed.

The bandwidth and the center i-f frequency may be determined by connecting a signal generator, tuned to the center i-f frequency, across the frequency modulated or, sweep gen-

(Continued on page 28)

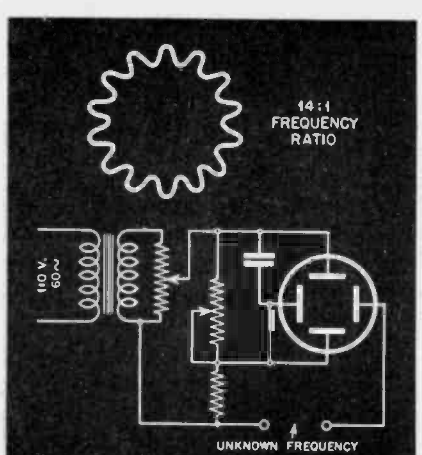

Fig. 8. Top—pattern of 14 to 1 ratio. Below—voltage for circular sweep may be taken from the 60 cycle line through this step-down transformer.

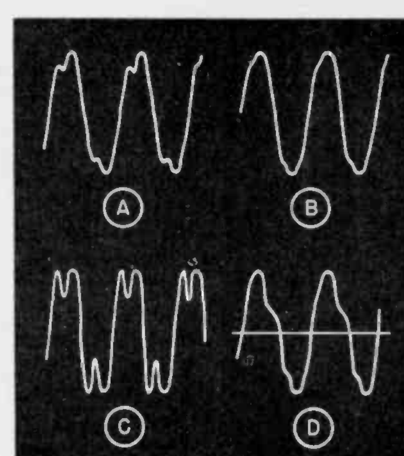

Fig. 10. Distortion as seen on a 'scope. A—high distortion; B—recognizable by ear; but permissible; C—very high distortion; D—objectionable distortion.

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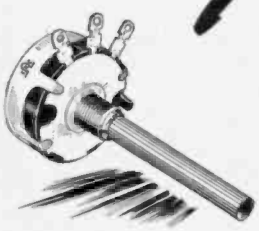

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TECHNICAL SERVICE PORTFOLIO

SECTION XXX

ABOUT CONDENSERS

MUCH has been written about condensers. In articles and books you will find a great deal of useful information regarding the characteristics of condensers, methods of testing and troubles to which they are subject in service. But it is a curious fact that nowhere—at least so far as this writer has been able to determine—will you find any concrete data as to the actual values of insulation resistance, power factor, Q, or any other characteristic of importance in condensers. To be sure, in instruction books accompanying condenser testers, information is given as to what constitutes a leaky condenser, what is considered a high power factor, and other useful information which will enable the user to get the most value out of his test instrument. But this information is often far, far too easy to misunderstand. When, for instance, you read that an insulation resistance of 60 megohms is perfectly satisfactory for bypass purposes, it is easy to assume that a condenser giving such a test reading is perfectly good. Such is not necessarily the case. For a low-voltage, high-capacity electrolytic, perhaps, this might be quite passable. But for any mica or paper type, it would mean that the condenser had a good deal more than one foot in the grave.

So we feel that there is some point in taking up in detail many of these items which have been so obscure in the past to all of us. We shall learn not only what readings we may expect to find in merely passable condensers, but also what constitutes top-notch condition. For there are many times when no serviceman is justified in using anything but the best. Too often critical public address jobs have been lost through an unfortunate but easily preventable failure of a condenser which showed far below par on test, but which seemed satisfactory in performance. We shall look into some applications of condensers and see in just what type of circuits high excellence of characteristics is imperative, and also in what applications we need not be so particular.

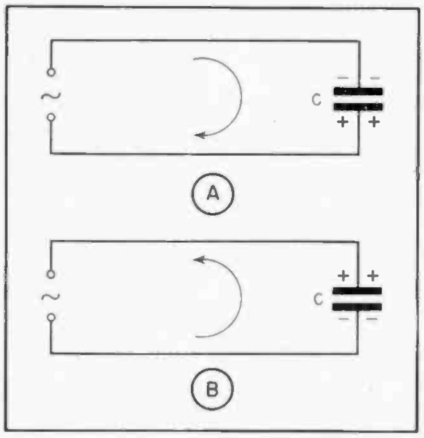


Fig. 1. When an alternating current is applied to a condenser, it goes through a charging cycle in one direction (A), and then in the opposite direction (B), discharging between cycles back into the line.

Operation and Losses

But first let us start at the beginning and see just how a condenser works, both theoretically and practically. In *Fig. 1A*, for example, we show an alternating voltage applied to a condenser. During the negative half-cycle of the applied voltage, electrons accumulate on one plate of the condenser as shown, forming a negative charge. This negative charge induces an equivalent positive charge on the remaining plate. If the voltage source were withdrawn at some instant while current was flowing into the condenser as indicated, we should find the polarities of each plate to be as indicated in *Fig. 1A*. Now, when the alternating voltage is again applied and the polarity of the voltage reverses, the original charge on each plate is discharged back into the voltage source, and is replaced, with the polarity reversed, with another charge as indicated in *Fig. 1B*.

Thus, in a perfect condenser, a charge is formed on each plate when current is applied of one polarity and discharged when the polarity is reversed, to be replaced by another charge of the opposite polarity. During this cycle of charge, discharge and recharge, the condenser constantly gives back to the voltage source during the discharging period the same amount of current which it receives from the source during the charging period. Thus no power is lost during these operations and we can say that the condenser has no losses.

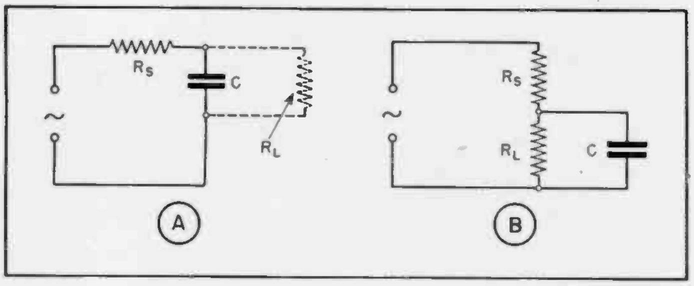


Fig. 2. All condensers have resistance which affects their efficiency. In (A) R_s is the series resistance and R_L the shunt resistance. These form a voltage divider as (B)

Such condensers do not exist, although the losses in a good air condenser, used at low frequencies, may be extremely small. Insofar as the condensers with which we are concerned in this article, namely, mica, paper and electrolytic types, losses are distinctly a factor in their performance. These losses occur in the dielectric used between the condenser plates and in the bakelite or other type of container used, if of a molded form or otherwise enclosed in insulating material. In the junction of the leads to the elements of the condenser, we find another source of imperfect operation, due to losses. In the best condensers of each type, these losses are low; but it is also true that what may be considered low losses in one type of condenser is much too high in another. For example, an excellent electrolytic condenser may have far higher losses than a relatively poor mica condenser. But it is of course unfair to compare an electrolytic condenser to a mica type, because the applications are so different. What we wish to emphasize is that we need some sort of yardstick to guide us in deciding what is good in one type of condenser and not good in another. In the final analysis, this depends to a considerable extent upon the application, but not entirely. For often we find that relatively poor characteristics may be tolerated in certain condenser applications without appreciably affecting the circuit performance, yet these same characteristics may provide a warning signal to indicate rapidly approaching failure of the condenser. That is the important point.

Thus, in a true condenser, some power loss must take place. This loss may conveniently be indicated by shunt and series resistance. The leakage which occurs between the plates of a condenser, due to imperfections in the dielectric between the plates, or to conduction between the condenser terminals across the surface of the case of the condenser, is the same as would occur if the condenser were shunted by a resistor, and may be represented as such in a drawing, as has been done in *Fig. 2*. Likewise, dielectric losses at high frequencies, the joints between the condenser leads and the condenser foil, as well as the contacting surfaces between connecting foils, can be shown as series resistance, as we have done. In addition, there are other losses which occur to a varying extent, depending upon the operating frequency, which affect the performance of the condenser. All are indicated by power factor and insulation resistance measurements.

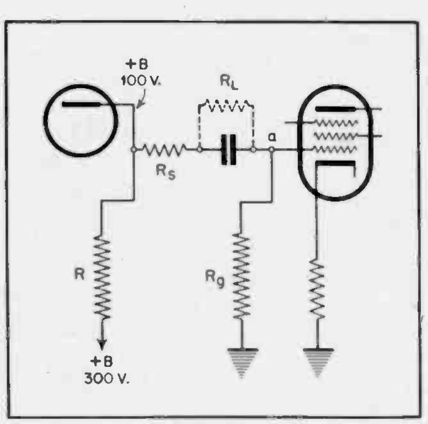


Fig. 3. In this coupling application the series resistance of the condenser is shown as R_s and the insulation resistance as R_L.

Power Factor Losses

Just how power losses as discussed above may occur can be seen from a study of *Figs. 2A* and *2B*. In *Fig. 2A*, we see the series resistance of the condenser leads and other contacting surfaces indicated as *Rs*, while the shunt resistance, representing insulation resistance and leakage is indicated as R_L. If we compare what takes place in a true condenser, as indicated in *Fig. 2*, with that which represents the ideal condition shown in *Fig. 1*, the difference is readily apparent. During the charging cycle, in *Fig. 2A*, the charging current must pass through both *Rs and* R_L, and in doing so some of this energy is lost; dissipated in the form of heat. The same condition takes place during the discharging cycle. Further, as the shunt resistance becomes lower and the series resistance becomes higher, more and more of the current in the circuit will pass through the resistances and less and less will be left to form charges on the condenser. This can readily be seen from a study of *Fig. 2B*. Note that the shunt and series resistors form the equivalent of a voltage divider. When the shunt resistance R_L is low and the series resistance *Rc* is high, which is a condition often encountered in very high radio frequency circuits, very little voltage is developed across the condenser *C*. Thus its bypass action is greatly reduced; it really makes very little difference in the action of the circuit whether or not the condenser is connected to it.

A tabulation of the characteristics of mica, paper and ceramic condensers is shown in *TABLE I*. This table covers the most important characteristics and the values shown represent the average of what *should* be found in new condensers of top-notch quality. The first-listed characteristic, Q, is a measure of the efficiency of a condenser in that the Q is high when losses, of all types, are low, and is low when the losses are high. Q is related to power factor in that it is substantially the reciprocal of the power factor when the losses in the condenser are not too high. The formula for Q in condensers is

$$Q = \frac{1}{R2\pi FC}$$

where C equals the capacity in far-

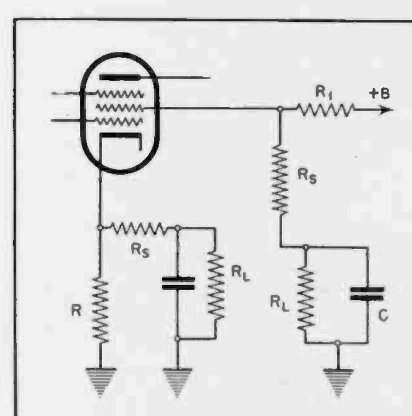


Fig. 4. In screen bypass and cathode bypass applications, as shown, the insulation resistance requirements are not so severe.

ads, F is the frequency in cycles and R is the resistance, due to losses, in the condenser. Q is usually measured at high frequencies, of the order of 1 mc, where radio-frequency losses show up; often they are not revealed by low-frequency measurements. Also, Q measurements are especially applicable to mica and ceramic condensers, because these types are so generally used in r-f circuits at relatively high frequencies.

Note the wide range of Q values given. For plain mica condensers, when the capacity of the condenser is low, the resistance losses are large in comparison with the capacity and therefore the Q is low. For best results, mica condensers of less than 100 mmf should employ low-loss bakelite, to reduce these losses to a minimum. At higher capacities, above .0005 mf, this is not so important.

Power Factor Measurements

Power factor measurements are usually made of capacities greater than .0005 mf, regardless of the type of condenser because the meter used for Q measurements is not adaptable to read directly values of Q for capacities greater than 500 mmf. Ordinarily the higher capacity values in mica condensers are used where lower frequencies are involved, and therefore the power factor measurements, at 1000 cycles, provide a good indication of the condenser quality.

Note that our tabulation states only that the power factor of new micas shall be less than 0.5%. Actually, it will be found that most high-grade condensers of the low-loss variety will read considerably less—perhaps 0.1 to 0.2%. Readings in this vicinity are quite apt to be inaccurate due to unavoidable difficulties encountered in such measurements; but a condenser which reads better than 0.5% is above suspicion.

The power factor of paper condensers closely approximates that of mica condensers because of the low frequencies at which such measurements are made. If we were to measure the Q of paper condensers, we should generally find it to be very low, less than 100, assuming that the measurements are made at high frequencies, of the order of 1 megacycle. Since paper condensers are normally used for low-frequency bypassing their lower efficiency at high frequencies is not too serious.

Ceramic Condensers

We haven't discussed ceramic condensers as yet, and this is about as good a time as any to talk about them. These are the little tubular condensers which look so much like resistors that many a receiver has been wrecked by zealous servicemen who have applied an ohmmeter to this condenser and, finding its resistance unreadably high, have snipped it out of the circuit as being an open-circuited resistor. You can guard against this embarrassing state of affairs, if you have never to date encountered any such condenser, by taking a good look at any resistor-shaped component whose function is not altogether clear. Ceramic condensers are hollow tubes, while practically all composition resistors are solid—that's one way of identifying them.

These ceramic condensers vary in size according to their capacity and temperature coefficient. The lower-capacity, negative-temperature-coefficient types are no larger than some ¼-watt resistors. They are quite excellent electrically, comparing favorably with the best micas, but they get to be rather bulky in the larger capacity values, so they have not replaced micas to any appreciable extent. Their most common application is in tuned circuits which must have high frequency stability, such as superhet oscillators and some types of i-f circuits. They can be made to change in capacity with a change in temperature in a direction opposite to that of coils and other circuit components, so that the tuned frequency of the circuit tends to be kept constant. Thus the change in frequency as a result of an increase in the temperature surrounding a coil may be such as to decrease the frequency by increasing the inductance of the coil. If the capacity of a condenser shunted across this coil is caused to decrease as the surrounding temperature increases (which is the same as saying that the condenser has a negative temperature coefficient) the effect will be to counteract the change in frequency which would otherwise result because of the temperature change. These ceramics can be made with a wide range of temperature coefficients to meet varying circuit requirements—from a positive coefficient of .012%/° C. to negative coefficient of .075%/° C.

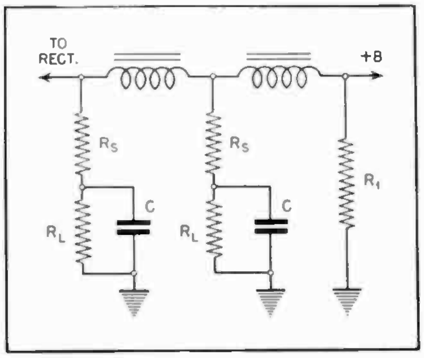


Fig. 5. In this filter circuit, it is seen that low power factor, represented by a low value of series resistance R_s, is more important than high insulation resistance.

Silver Mica Condensers

The distinguishing feature of silvered mica condensers, as compared

TABLE I

CHARACTERISTICS OF MICA, CERAMIC AND PAPER CONDENSERS

	Mica Plain	Mica Silvered	Ceramic	Paper
Q (at 1 mc) (a)	50 to 1400	200 to 1400	Up to 1250	
Power Factor (at 1 kc)	less than 0.5%			0.25 to 1.5%
Temp. Coeff. (°C.)	0.03% (max.)	0.005%	.012 to .075%	(b) 0.1% (max.)
Insulation Res. (megs)	10,000 (min.)		10,000 (min.)	(c)

Notes: (a) The Q decreases rapidly in low capacity ranges; above 250 mmf the upper limit shown applies. For high capacity values, power factor is measured.

(b) This temperature coefficient applies over an ambient temperature range of from about 32 to 150 degrees Fahren. At very low temperatures, the capacitance of some types of paper condensers decreases.

(c) The insulation resistance of various types of impregnated paper condensers depends upon the capacity. See text.

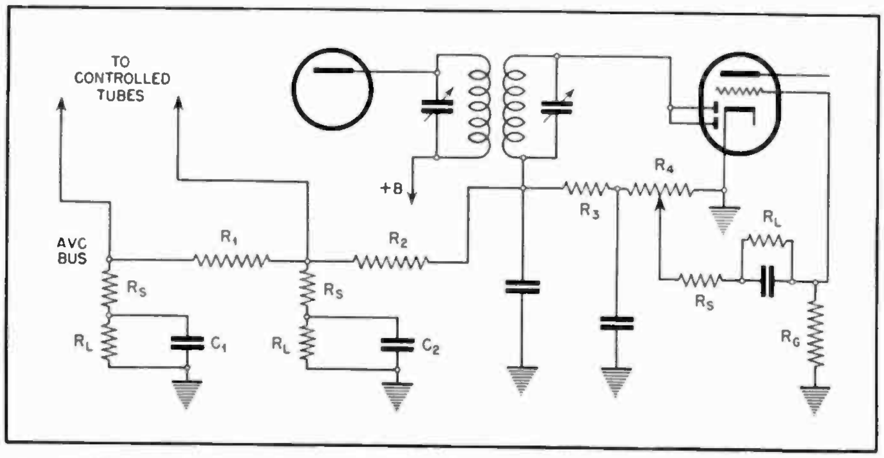


Fig. 6. High insulation resistance in C1 and C2 is not so important as in the coupling condenser from the diode detector to the amplifier stage.

with the ordinary types, are their excellent capacity stability with changes in temperature. While they are not adaptable to the compensating action obtained with ceramics, they are much smaller (in the higher capacity values) and for most circuit applications are very satisfactory. They are made only in low-loss bakelite because the ordinary brown bakelite introduces losses which would limit the stability of the condenser.

Impregnated and Oil-Filled Types

Paper condensers are made in a wide variety of types, though the type most frequently used in commercial radio applications is wax-impregnated. As most of us know, when the cardboard tubular form is employed, high temperatures frequently cause the wax to melt and eventually the condenser deteriorates. Enclosing the condenser in metal helps to overcome this fault. Electrically, though, these wax-impregnated types compare very favorably with the more expensive oil-filled types generally employed in expensive apparatus.

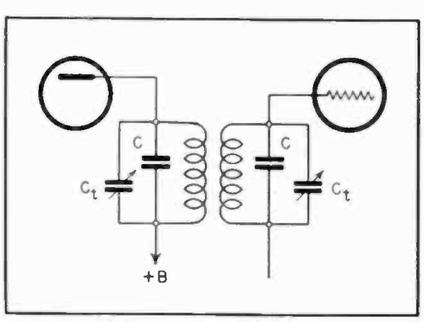


Fig. 7. Temperature compensating condensers, C, tend to keep the frequency of this i-f transformer constant as the surrounding temperature varies.

Of the oil-filled condensers, three types are available. Mineral-oil filled and impregnated condensers are designed to meet the most exacting requirements over a wide temperature range, but their greater bulk and expense precludes their use in most commercial apparatus. Often there is little need for their great temperature stability; home radios are not operated over a wide temperature range. These condensers also have a low power factor, but for bypass purposes at low frequencies—and these condensers are not intended for use at high frequencies—these advantages are not too important.

Vegetable-oil filled and impregnated condensers are also available for use in high-grade p.a. systems and the like. While such condensers can be made somewhat smaller than mineral-oil types, they are likewise comparatively expensive and their use is accordingly limited to apparatus where cost is relatively unimportant. These show somewhat lower insulation resistance than mineral-oil condensers but it is still so very high that this deficiency is unimportant. They are suitable for use over a wide range of temperatures and are noted for their long life and reliability. The use of a vegetable oil (usually castor oil) makes possible rubber insulation against moisture at the point of entry of the leads to the interior of the condenser, improving the seal against humidity and thus prolonging the condenser life. Mineral-oil types are obliged to use synthetic rubber at such points.

The third type of paper condenser is impregnated and filled with a synthetic oil known as chlorinated diphenyl. Commercially this appears under trade names such as Pyranol and Dykanol A. Such condensers have low power factor and high insulation resistance. Further, they are compact; a can half the size of that required for a given capacity in mineral oil is adequate for a chlorinated diphenyl type. Such condensers are designed for operation as filter and bypass condensers, as well as for coupling purposes. They do not have the capacity stability at low temperatures which is characteristic of mineral oil types, but this is quite unimportant in any of the circuits designed to use them.

The insulation rating of condensers of the paper types is based on the capacity in microfarads and the resistance in megohms. A large capacity condenser cannot be expected to have so great an insulation resistance as a smaller condenser, without increasing its physical size to a prohibitive degree, because of the thickness of paper required. Accordingly, a rating is established for a representative 1-mfd condenser, at say 500 megohms minimum, and this rating is increased proportionately as the capacity decreases. Thus an 0.5-mfd condenser would have a rated insulation resistance of 1000 megohms, and 0.25 mfd type at 2,000 megohms, etc. A practical limit is reached at around 5,000 megohms. Insofar as circuit operation is concerned, 500 megohms should be adequate in practically any application . . . but it is well to know just how good the condenser should be in order to determine if any deterioration has taken place. Once started, most deteriorating conditions cause rapid decrease in the life of the condenser.

(Continued on page 32)

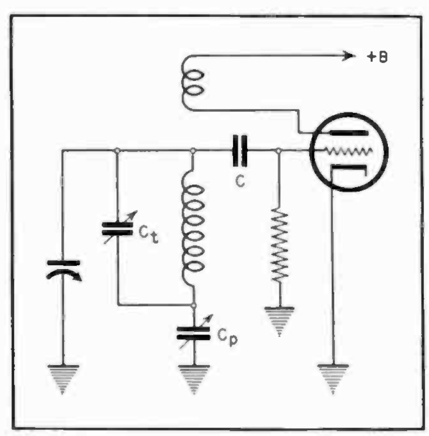


Fig. 8. In this oscillator circuit, the trimmer C_t is of the temperature-compensating type.

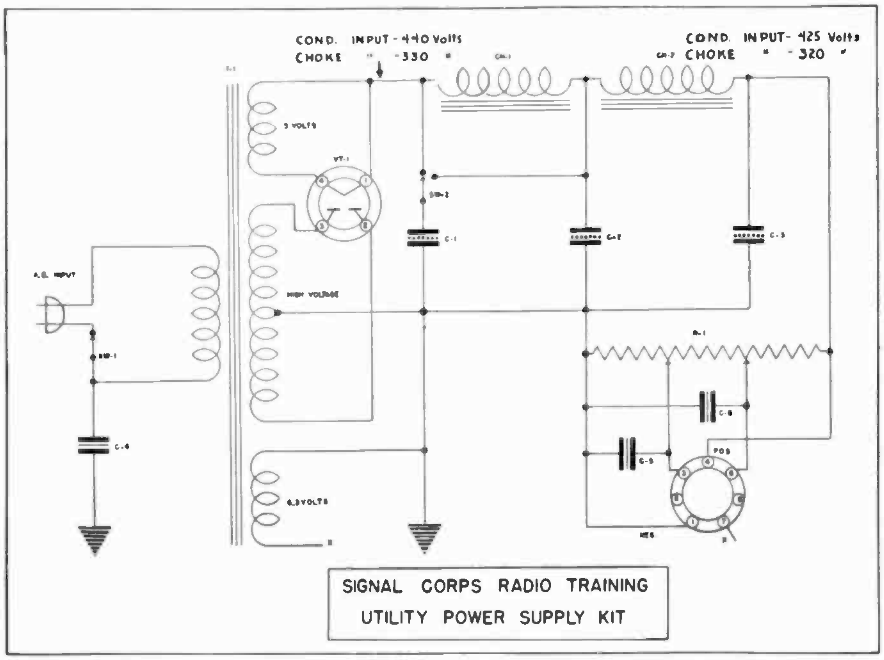


Fig. 1. Kit Components

Quantity		*Description*
1	T-1	Power Transformer
1	CH-1	Filter Choke
1	CH-2	Filter Choke
1		Punched and drilled chassis, wrinkle finish
1	R-1	25M ohm Resistor with one slider
1		Extra slider for R-1
1	SW-1	SPST Toggle Switch
1	SW-2	SPDT Toggle Switch
1		On-Off Switch Plate
1	C-1	8. mfd. 450 volt condenser
1	C-2	8. " 450 " "
1	C-3	8. " 450 " "
1	C-4	.1 " 600 " "
1	C-5	.25 " 600 " "
1	C-6	.25 " 600 " "
2		Mounting Lugs
1		A.C. Line Cord, with attached plug
1		4 Prong Socket for Rectifier Tube
1		Rubber Grommet
1		7 Prong Voltage Terminal Socket
1		7 Prong Plug for above socket
18"		Resin Core Solder
4'		Stranded Push-Back Hook-Up Wire
10"		Spaghetti Tubing
1	VT-1	R.M.A. Type 80 Vacuum Tube
4		8/32" x 5/16" Hex Nuts
10		6/32" x ¼" R.H.M. Screws
10		6/32" x ¼" Hex Nuts
2		Mounting Brackets for R-1

SIGNAL CORPS TRAINING KITS

By J. P. Hollister

WE believe that one important reason why the Signal Corps has been so successful in rapidly training men for technical radio work is due to the sound practical experience the trainees get in building radio apparatus which is both workable and useful. Some of these units are designed for radio testing, and because the same principles are involved whether we are testing Army or civilian radios, some of these units will be found most welcome in many service shops, now struggling to get along with inadequate equipment. These units are simple to build—they have to be, for inexperienced trainees — but they work, and we feel fortunate to be able to present to our readers full constructional details on many of these kits. For those who expect to be called in the draft, a study of these components will enable them more rapidly to qualify in any training course of this sort to which they may be assigned. For others, the utility of the finished units will more than pay for the time involved in construction.

For radio servicing, the most useful units are the signal generator, the utility audio amplifier and the utility power supply. Let's consider the last-named first, because the power supply is intended to furnish power for many of the other units, none of which has its own power supply. The schematic diagram, *Fig. 1*, shows the circuit. The type 80 rectifier is used in a conventional full-wave rectifying circuit, but the filter is so designed that either choke or condenser input may be used. This is done by means of *Sw-2*, which may be thrown to connect *C-1* across *C-2*, so that the input of the filter becomes the choke, *CH-1*. Or, with the switch in the position shown, the standard condenser input circuit results.

The advantages of both condenser and choke input circuits are thus realized in a single power supply. When a high voltage at relatively low current is needed, the condenser

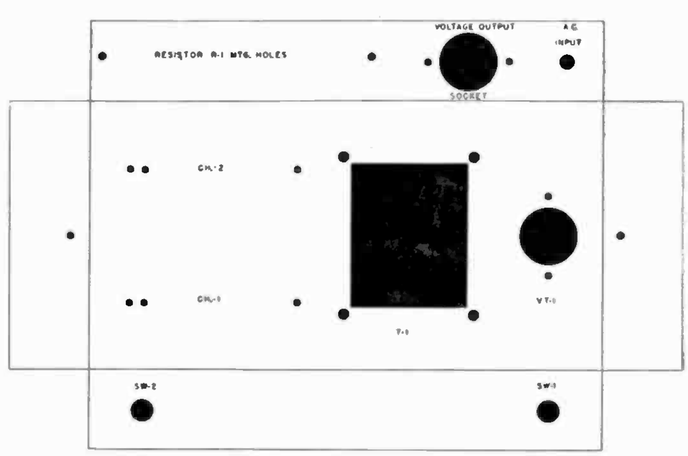


Fig. 2. Chassis layout for the power supply.

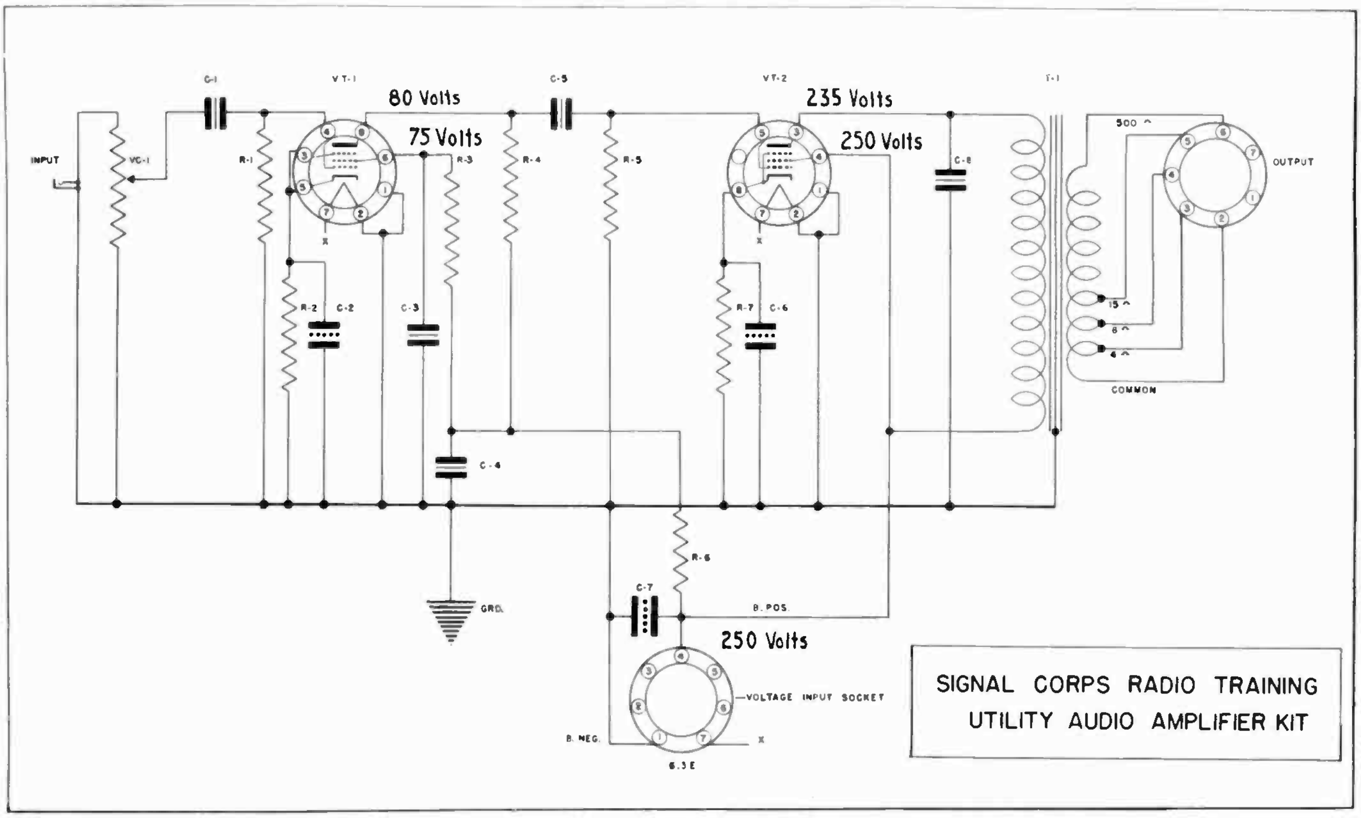


Fig. 3. Kit Components

Quantity		*Description*						
			1	C-5	.1 mfd. Condenser, 400 volts	1		Input Connector Plug
			1	C-6	10. " " , 50 "	2		8 Prong Octal Sockets
1		Chassis, Punched, Drilled, & B.W. Fin.	1	C-7	8. " " , 450 "	1	*	Shield for 6SJ7GT tube
1	VT-1	6SJ7 or 6SJ7GT R.M.A. Vacuum Tube	1	R-1	300M ohms ½ Watt Resistor	2		7 Prong Sockets
1	VT-2	6F6 or 6F6GT R.M.A. Vacuum Tube	1	R-2	2200 " ½ " "	2		7 Prong Connector Plugs
1	VC-1	1 Megohm Volume Control	1	R-3	300M " ½ " "	18"		Rosin Core Solder
1	T-1	Shielded Output Transformer, tapped	1	R-4	100M " ½ " "	4'		Stranded Push Back Hook-up Wire
		at, 4, 8, 15 and 500 ohms	1	R-5	300M " ½ " "	1		Schematic Diagram & Chassis Layout
1	C-1	.006 mfd. Condenser, 400 volts	1	R-6	10M " ½ " "	4		8/32" x 3/8" R.H.M. Screws
1	C-2	10. " " , 35 "	1	R-7	300 " 1 " "	4		8/32" x 5/16" Hex. Nuts
1	C-3	.1 " " , 400 "	1		Knob for volume control	8		6/32" x ¼" R.H.M. Screws
1	C-4	.1 " " , 400 "	1		Chassis Input Connector	8		6/32" x ¼" Hex. Nuts

* Not furnished when metal 6SJ7 is supplied. Note: Only one-half of the primary of T-1 is used.

input circuit may be employed. Under these conditions, the resulting output voltage across the bleeder resistor *R1* is 425 volts. While this voltage will be reduced in proportion to the amount of current taken by the apparatus to which it is connected, this voltage is normally rather high for many applications. With the circuit adjusted for choke input, the voltage across *R-1* is reduced to 320 volts and the regulation is much improved. However, the degree of hum filtration is somewhat greater with condenser input.

The flexibility of such a power supply adapts it to many uses around the radio service shop. In trouble-shooting, especially with intermittents, it is sometimes advisable to substitute another power supply in order to make certain whether or not the trouble is in the power supply circuit of the receiver under test. In other cases, where the customer requires an estimate before agreeing to allow work to be done, it is well to restore operation (when the main cause of inoperation is due to a power supply defect, such as a blown condenser or power transformer) and check such items as the volume control, tone control, etc., to make certain just how much work has to be done on the set before giving an estimate. The power supply has other uses, of course, in serving as a test source for leaky condensers, and as a source of power for other test equipment.

The chassis layout for the power supply, shown in *Fig. 2*, represents the arrangement used in the commercial kit made available for constructional purposes. If other parts are used, they may not fit this chassis, which is punched and drilled for specific units. However, the same layout may be used with such modifications as may be necessary to accommodate the components substituted.

The Utility Audio Amplifier, shown in *Fig. 3*, is a simple two-stage, high gain amplifier which is rated to give about 3 watts undistorted output. As with the power supply unit, this amplifier may be substituted for the audio section of a receiver under test, in order to localize obscure sources of trouble and intermittent operating conditions. The amplifier does not have sufficient gain for some types of crystal microphones, but it should be useful as a small p.a. unit when carbon, or similar types of

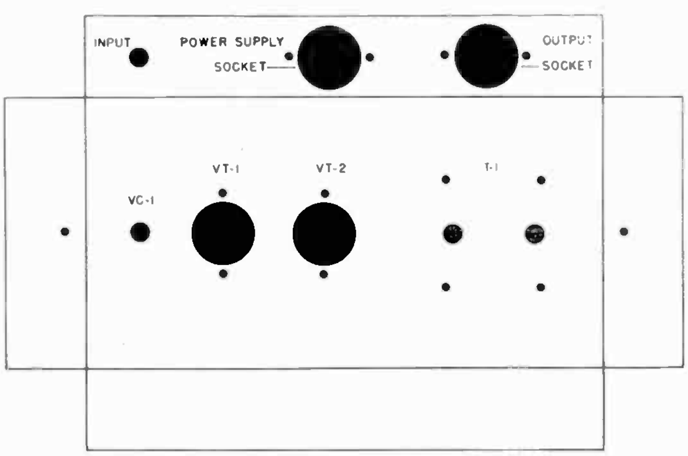


Fig. 4. Chassis layout for the utility audio amplifier.

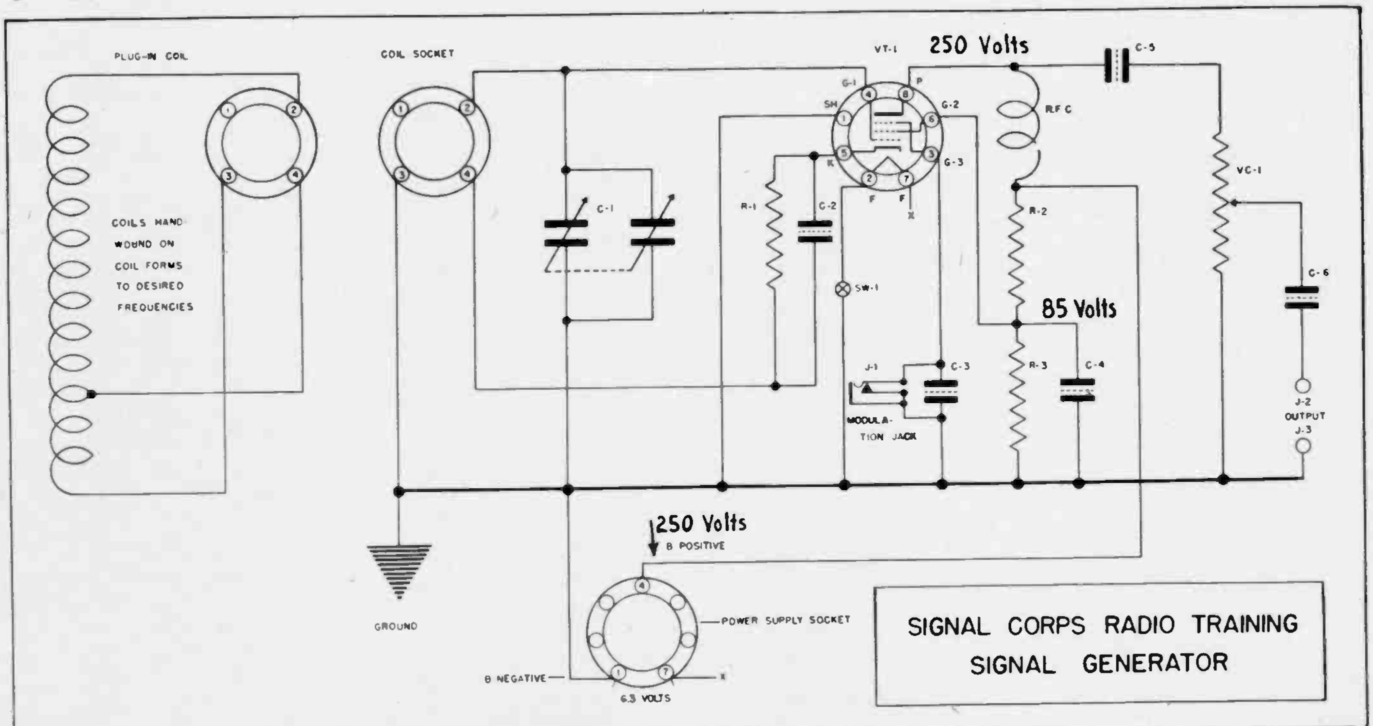
microphones with high output are available. Further, it will work nicely with any type of phonograph pickup. Note the socket used for the output terminals. This idea might be employed to advantage in many commercial p.a. amplifiers. By using an assortment of 7-prong plugs, it is possible to obtain any of the supplied output impedances without bothering to wire in connections, as is commonly the case. The layout for the punched and drilled chassis is shown in *Fig. 4*. *(Fig. 5 is below)*

Getting around to test equipment, the signal generator circuit shown in *Fig. 5* meets the need for a signal source which will provide plenty of "sock" for testing and aligning receivers. This is more of a tailor-made proposition than any of the other instruments and should prove a very interesting kit to play around with. No coils are provided; you roll your own. In doing so, a good tip to remember is that increasing the number of turns four times on a coil will cut the frequency in half, other things remaining equal. Thus, if you find that 5 turns on a 1-inch coil, close-wound, results in an oscillator frequency of 6 mc, when shunted by the full capacity of the 365 mmf tuning condenser, then increasing the number of turns to 20 will result in an output frequency of about 3 mc. You can check your frequencies by hooking up a receiver to a good antenna, tuning in a station, then adjusting the test oscillator frequency until it produces a beat or squeal in the receiver speaker. The receiver should then be tuned to twice the original frequency, at which the oscillator signal should again reappear. This will be the second harmonic of the original oscillator frequency. This check is necessary to make certain that the signal originally tuned in was not a harmonic, rather than the fundamental, oscillator signal frequency.

The oscillator is a 6SK7 employed in what is usually termed an electron-coupled oscillator circuit. The oscillating circuit itself is a Hartley type, and each coil is tapped at about one-third to one-fifth the total number of turns between the ground end and the cathode tap. If the tap is taken too high up on the coil, parasitic oscillation may occur, indicated by a number of output frequencies close to the desired frequency. If there are insufficient turns included between the tap and ground, the circuit will not oscillate, or will oscillate over only a portion of the tuning range. In general, it is best to keep the number of turns between the cathode tap and ground to a minimum, since this gives the best wave form. For most ranges (except very high frequency ranges) the minimum number of turns should be determined with the tuning condenser at full capacity setting, because this is the condition where most feedback, and therefore the greatest number of turns on the coil, is required to make the circuit oscillate. If "dead spots" occur over the tuning range, the wiring should be looked over and leads shortened and dressed away from the coil until the condition disappears. In general, this results from the leads acting as little tuned circuits in themselves which absorb energy at their resonant frequency from the coil circuit and thus cause the circuit to fail to oscillate. Sometimes it is possible to increase the feedback and make the circuit oscillate, even though there are absorptive circuits in the field of the coil, but this should not be done if it can be avoided. Often the presence of these coupled circuits, resulting from long leads or incorrect placement of the leads, causes a shift in the frequency of oscillation as the coil is tuned over the range—in any case, it causes uneven strength of oscillation at different points in the tuning range, which affects the usefulness of the oscillator.

In testing the signal generator, the uniformity of oscillation—or the lack of it—may be checked by inserting an 0-10 ma milliammeter in

1	VT-1	6SK7 or 6SK7GT R.M.A. Vacuum Tube
1		Black Wrinkle Cabinet and Chassis
1	C-1	365 mmfd. dual section condenser
1	C-2	.002 to .003 mica cond. fixed.
1	C-3	.00015 mfd. mica cond. fixed.
1	C-4	.002 to .003 mica cond. fixed.
1	C-5	.00015 mfd. mica cond. fixed.
1	C-6	.00 to .003 mica. cond. fixed.
1	R-1	Resistor 4m ohms 1 watt
1	R-2	" 50m " 1 "
1	R-3	Resistor 50m ohms 1 watt
1	VC-1	Variable 10m ohms potentiometer
1	SW-1	Switch mounted on back of "
1	J-1	Closed circuit jack
1	J-2	Red tip jack
1	J-3	Black tip jack
1		Two circuit phone plug
1	R.F.C.	2½ mh. 150 ma. 50 ohms R.F. Choke
3		4 prongs, coil forms
1		Spool #34 or #36 D.C.C. Wire
2		Bar knobs 1¼"
4'		Stranded push-back hook-up wire
18"		Rosin core solder
1		Handle
4		Bumper feet
1		7 prong male plug
1		7 prong socket
1		4 prong socket
1		8 prong octal socket
12		PK #6 x ¼" self tapping screws
6		6/32" x ¼" hex nuts
1		Dial plate



series with *R1* and the point to which it connects to *C2*. Alternatively, the connection may be made by cutting it in series with the *B plus* lead. Oscillation will be indicated by a decrease in plate current as compared with the reading obtained with the non-oscillating condition. We can make sure that the circuit is not oscillating by grounding *G1*. When the circuit oscillates weakly, oscillation can sometimes be stopped by simply touching *G1*, but a good healthy oscillator doesn't pass out quite so easily. A large change in plate current—or cathode current—indicates strong oscillation. If the plate current reading remains substantially the same throughout the tuning range, the oscillation output is uniform. This happy state of affairs is seldom realized. Usually the change in plate current between the oscillating and non-oscillating conditions will be about two or three times as great at one end of the tuning range as it is at the other, especially with an oscillator of such simple design. This, however, does not affect the usefulness of the kit for training purposes or, for that matter, for most radio service purposes either.

The output level is controlled by the potentiometer *VC-1*. To be effective, the oscillator must be enclosed in a shielded cabinet. The coils should be small, especially for the higher frequency bands, if used. A diameter of ½ to ¾ inch is not too small. If made larger, there will be so much signal leakage from the case that the output control will be ineffective in reducing the signal level. Even under the best conditions, it will be found that minimum signal output will not be obtained with the potentiometer *VC-1* at a minimum setting. A shielded cable, connected to *J-2 and J-3*, with the shield grounded to *J-3*, will help to prevent much of the signal leakage from reaching the receiver input circuit.

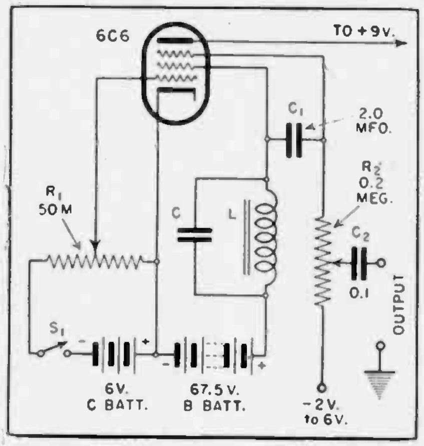


Fig. 6. Circuit of an audio oscillator.

Modulation is obtained by injecting an audio signal into the suppressor grid circuit, by means of the jack *J-1*. The simplest way of doing this is to use a 60-cycle signal, which may be obtained from a filament transformer or from an unused filament winding of the utility power supply transformer. Only a few volts are required and it is convenient to make this modulation voltage adjustable, by shunting a potentiometer across the modulation voltage source and applying only the voltage between the moving arm and ground to the suppressor grid. If some other frequency is desired, then a separate audio oscillator may be rigged up, such as that illustrated in *Fig. 6*. This simple audio oscillator uses the negative conductance or "transitron" circuit, and can be arranged to oscillate at any frequency in the audio or r-f range simply by changing the coil and condenser. For the a-f range, an audio choke of the a-c/d-c set type, shunted by a .005 or larger condenser, depending on the frequency desired, should be very satisfactory.

It is well to remember that modern receivers really don't require an audio modulated signal for aligning purposes. The simplest and best way to align a receiver is with an unmodulated signal, which is far sharper than the usual 400-cycle modulated signal, peaking each stage by adjusting each circuit for maximum indication of a voltmeter or "magic eye" connected across the avc bus. Where we really need modulation is in checking for fidelity of reception, and one excellent way of providing such modulation, which has never become as popular as it should, is by using a turntable and records. Many do not realize that "constant-frequency records," recorded to give a uniform output level over a frequency range of from 30 to 10,000 cycles, may be obtained, and serve to identify the frequency range of the receiver under test. Further, voice and orchestral records may be employed for an actual check of reception under permanently stable conditions. The output of the record may be run through any audio amplifier before coupling to the oscillator which it is to modulate.

These kits may be obtained from the Lafayette Radio Corporation, and include the components listed on each parts list. We are indebted to the U. S. Signal Corps for permission to describe these kits and to the Lafayette Radio Corporation for supplying the schematics and parts lists reproduced herewith.

Data regarding additional kits are now in preparation. Next month the several Meissner Signal Corps and Student Training Receiver Kits will be covered.

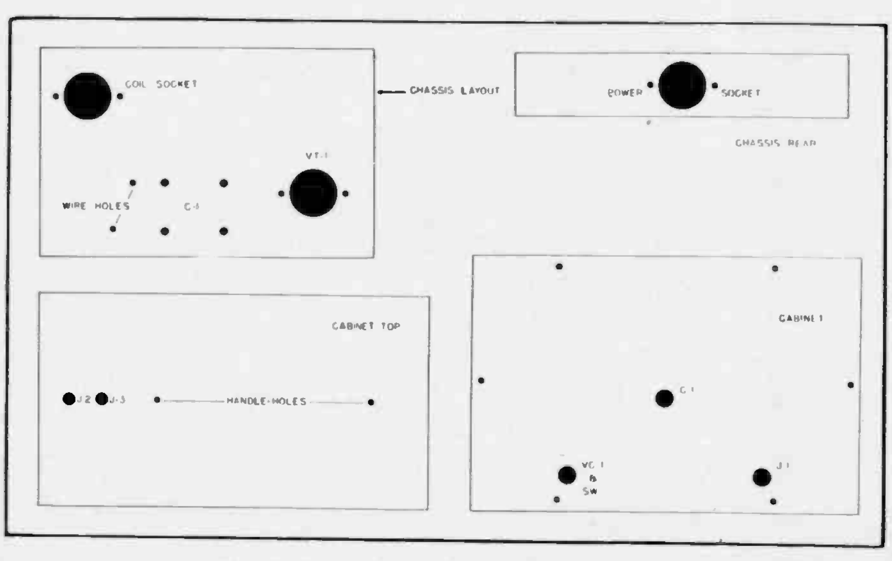


Fig. 7. Chassis layout for the signal generator.

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"PREFERRED TYPE CAPACITORS" ANNOUNCED

»» Solar Capacitor Sales Corporation, Bayonne, N. J., announce the adoption of a new policy of capacitor standardization, in anticipation of inevitable Government? enforced standardization.

New Solar Catalogs V-1 and V-2 have been issued, illustrating a minimum number of types specifically designed for a maximum number of applications.

THE SUPERHETERODYNE RECEIVER

by Oscar E. Carlson

INTRODUCTION—The superheterodyne receiver is the only type of receiver in general use today. Everyone who becomes thoroughly familiar with the underlying theory of the superheterodyne receiver will have a basic knowledge of radio transmitter circuits since these are made up primarily of enlarged components identical otherwise to receiver components. They will have learned the fundamentals of alternating current theory, resonant circuits, rectifiers, filters, vacuum tube theory, etc. This article covers briefly the majority of the circuits of a typical superheterodyne receiver. It is more than a review or "refresher", as the reader will discern.

WHEN two signals of slightly different frequencies are superimposed, the envelope of the resulting oscillation varies in amplitude at a frequency that is equal to the difference between the frequencies of the two alternating currents. It swings through an amplitude range equal to the crest amplitude of the smaller of the two voltages. This result is obtained because at one moment the two waves will be in phase and so will add together, while a short time later the higher frequency will be one-half cycle ahead of the other wave and so will add in phase opposition. The rate at which the amplitude of the envelope varies is called the beat frequency. The production of such beats by combining waves is called "heterodyning." Since such a signal when rectified gives a rectified current that varies in amplitude with the beat frequency, heterodyning provides a means of changing the frequency of an alternating current. In the beating of an unmodulated wave with a modulated wave the character of the modulation remains in the resultant beat. This is the underlying principle upon which superheterodyne receiver action is based.

Among the principal advantages of the superheterodyne circuit are:

(1) Amplification at a low frequency so that full advantage may be taken of the amplification properties of modern tubes

(2) Practically uniform selectivity over the entire tuning range of the receiver.

Fig. 1 illustrates superheterodyne action in block form The received r-f signal is the same as for a tuned r-f receiver. The amplified output of the r-f, or pre-selector stage, is an enlarged reproduction of the received signal. This signal voltage is fed into the mixer, or converter. In addition, the local oscillator feeds an unmodulated signal into the converter. The two signals combine and produce a third or lower carrier frequency having the same modulation characteristics as the received signal. This is shown by the fact that the shape of the wave envelope of the signal out of the mixer is the same as that of the received carrier. The fact that the newly created carrier has a lower frequency is shown by the reduced number of cycles within the envelope. This new modulated carrier is the i-f, or intermediate frequency signal. It is amplified in the i-f amplifier stages and passed to the detector, or demodulator. This is also called the second detector,

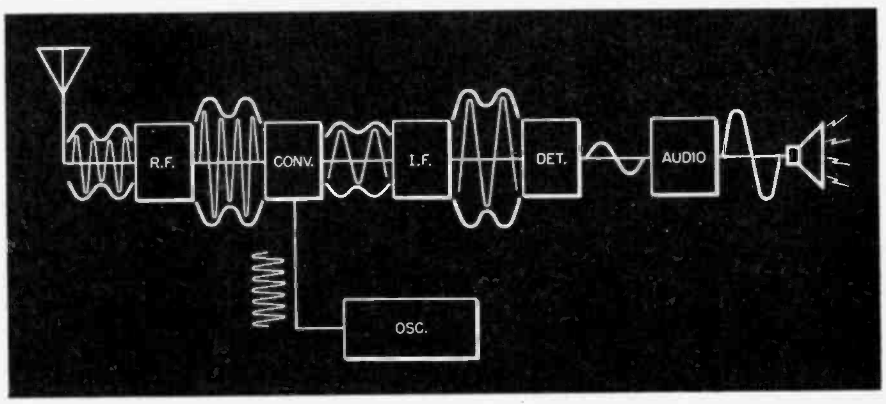


Fig. 1. Superheterodyne receiver block diagram

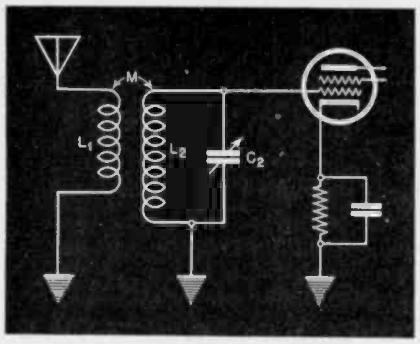


Fig. 2. High impedance mutual coupled antenna circuit

and here the modulating component is separated from the i-f carrier and passed into the audio amplifier.

Radio Frequency Voltage Amplifiers

There are two general types of radio frequency voltage amplifiers. The first one to consider is the r-f input circuit which follows the antenna and proceeds the first amplifier grid. The second, which we will consider later, is the r-f interstage circuit which operates from a vacuum tube and supplies signal voltage to a following amplifier tube grid. The most widely used antenna circuit for use with a separate antenna, outside antenna, is the High Impedance Mutual Coupled Antenna Circuit. The primary inductance, L_1, is designed to have a resonant frequency below the lowest tuning range of the receiver. A schematic of such an input circuit is shown in *Fig. 2*.

The equivalent circuit of this antenna circuit may be derived by consideration of Thevinin's Theorem, and by use of the equivalent circuit of a two winding transformer. This is shown in *Fig. 3*. The gain for this circuit

$$\frac{E\ out}{E\ in} \text{ is } MQ_2 \frac{\omega^2 C_a}{\omega^2 L_1 C_a^{-1}}$$

Where:

M is the mutual inductance in henries

Q_2 is the secondary inductance Q

L_1 is the primary inductance in henries

C_a is the antenna capacity in farads.

Most antennas used below a frequency of about 3 mc are less than one eighth wavelength long and are capacitive antennas.

$\omega^2 L_1 C_a$ is equal to unity at resonance for the primary. It is large compared to unity throughout the tuning range when the resonant frequency of the primary is about one-half the lowest frequency to which the receiver is designed to operate. The approximate gain of such a circuit is therefore

$$\frac{MQ_2}{L_1}.$$

Interstage RF Amplifiers

Interstage r-f amplifiers are used between vacuum tubes to amplify and select the desired signal voltage supplied by the input stage from the antenna. In general these amplifiers may be divided into two types: (1) those that are designed to operate from a triode amplifier tube; and (2) those operating from a pentode amplifier tube. These may be further subdivided into two types: fixed tuned and variable tuned. The fixed tuned include i-f amplifiers for the most part, while the latter type includes tuned radio or signal frequency amplifiers. Most receivers used today employ pentode tubes in the r-f circuits. *Fig. 4* illustrates Single Tuned Circuit r-f amplifiers.

The circuit illustrated in *Fig. 4B* gives the best performance. The radio frequency choke must have much larger inductance than the inductance, L_1, which is tuned by the variable capacity, *C*. In the circuit of *Fig. 4A* and *4C* the resistor, *R*, loads the tuned circuit and lowers the effective *Q* by an amount depending on the value of the resistance and the circuit impedance $Q_\omega L_1$. The gain of any of the three circuits illustrated is:

$$\text{Gain} = GmQ_1 \omega L_1.$$

Where:

Q_1 is the effective Q of L_1 in its respective circuit.

ω is $2\pi F$

L_1 is coil inductance in henries

Gm is the mutual conductance of the tube in mhos.

The gain may be approximated to *GmR* for ultra-high frequency circuits where *R* is small compared to the circuit impedances. The gain of any of these circuits is a function of *Q* only, and may be determined from the Universal Resonance Curve shown in *Fig. 5*. For the further explanation of the Universal Resonance Curves, it is suggested that the texts mentioned in the bibliography appended to this article be studied.

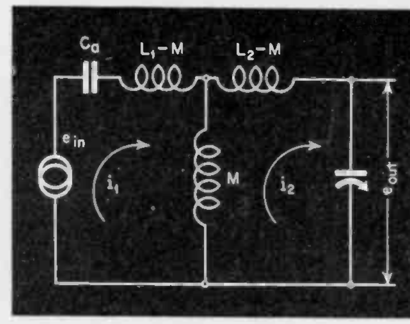


Fig. 3. Equivalent circuit for Fig. 2

Mutual Coupled Interstage Circuits

There are two common types of mutual coupling circuits and both are shown in *Fig. 6*. They are both the same as to schematic. The only electrical difference is in the resonant frequency of the primary cir-

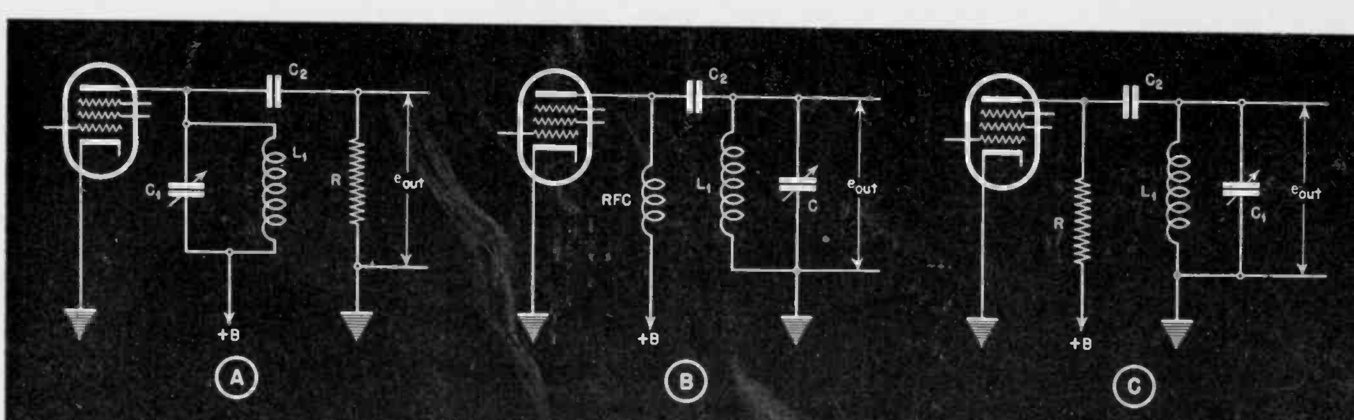


Fig. 4. Single tuned circuit R-F amplifiers

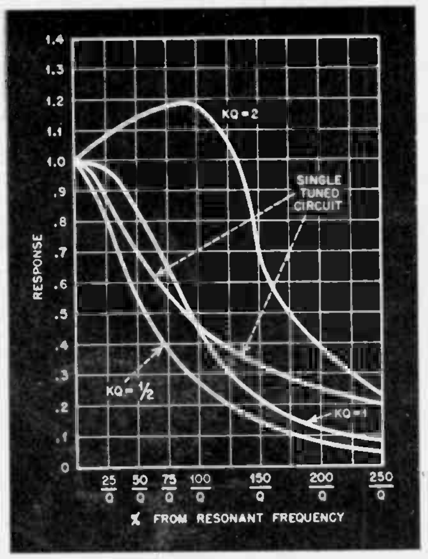


Fig. 5. Universal resonance curves

cuit. This may be either higher or lower than the receiver tuning range. With the primary circuit resonant to a frequency higher than the receiver tuning range the antenna should be resonant to a frequency above the tuning range also. The gain for such a circuit would be,

$$\text{Gain} = GmQ_2\,\omega M$$

where:

M is the mutual inductance between primary and secondary.

Since Q_2 is a function of the resonant frequency of the secondary circuit the gain varies directly with the frequency. As we can see by reference to *Fig. 5*, the selectivity of such a circuit may be ascertained by using the *Q* of the secondary circuit and the Universal Resonance Curve For Single Tuned Circuits.

In the low frequency primary circuits the primary is usually designed to resonant at a frequency of about one-third of the lowest frequency that the amplifier is to handle. This circuit is used extensively at broadcast frequencies and the gain formula is,

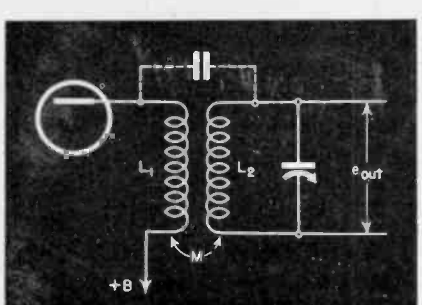


Fig. 6. Mutual coupled R-F amplifiers

$$\text{Gain} = GmQ_2 \frac{M}{\omega L_1 C_1}$$

this becomes: $GmQ_2X_c \dfrac{M}{L_1}$.

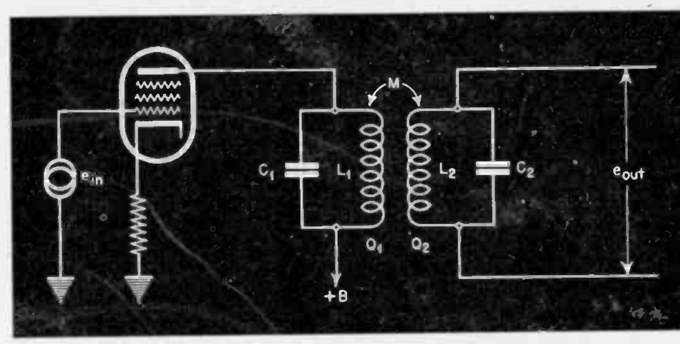
We can therefore see that for such an arrangement the gain is inversely proportional to frequency. This is usually corrected for by using capacity coupling between the high end of the primary coil and the secondary circuit. By the use of proper capacity it is possible to achieve constant gain over the receiver tuning range.

I.F. Circuits

As we stated under the advantages of the superheterodyne receiver, amplification is accomplished at a low frequency. At this low frequency, or i-f, amplification is fixed frequency amplification and the circuits can be very efficiently designed and constructed.

The most common type of i-f amplifier is shown schematically in *Fig. 7*. This is a double tuned circuit with

Fig. 7. Mutual coupled I-F amplifiers



the primary and secondary circuits both resonated to the same frequency. The gain of such a circuit is:

$$\text{Gain} = GmZ \frac{KQ}{1 + K^2Q^2}$$

where K is $\dfrac{M}{\sqrt{L_1 L_2}}$

and

when $Z_1 = Z_1\,\omega L_1;\; Z_2 = Q_2\,\omega L_2$

$$Z = \sqrt{Z_1 Z_2}$$

The maximum gain occurs when *KQ* is equal to *1* and this is generally termed critical coupling. Under that condition the formula for gain simplifies,

$$\text{Gain} = \frac{GmZ}{2}$$

The selectivity of a double tuned transformer may be determined from the Universal Resonance Curves as shown in *Fig. 5* for various values of *KQ*.

Oscillators

Most superheterodyne receivers employ either the Hartley or the Tuned Grid Plate Feedback Oscillator. Receivers of the communications type often employ the Hartley and a separate oscillator tube while most home receivers employ a combined Oscillator First Detector tube and circuit.

The Hartley Oscillator is normally used in all sets that employ a separate oscillator tube. The Hartley is a negative grid oscillator. It is essentially a vacuum tube amplifier with sufficient output energy coupled back to the input circuit to sustain oscillation. The grid is biased considerably negative with respect to cathode. The feedback voltage must be fed back to the input 180 degrees out of phase with the output voltage so as to add in the input circuit. This phase variation is accomplished by having the grid and plate connected to opposite ends of the combined grid-plate coil and the filament, or cathode, connected in between. *The grid excitation voltage is the voltage drop across the inductance between the grid and filament tap, it equals IX_1.* C_1 is the grid blocking condenser which has negligible reactance and C_2 places the plate of the tube at r-f ground potential. See *Fig. 8* for the circuit of a typical Hartley Oscillator.

To be continued next month

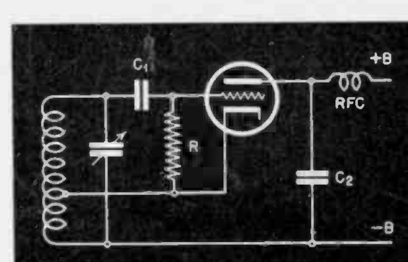


Fig. 8. Hartley oscillator

The Use Of Oscilloscopes

(*Continued from page 14*)

erator. A small pip will then ride the response curve at the center i-f frequency. By detuning this generaquency and noting the frequency deviation across the response curve we can measure the bandwidth of that curve.

In some commercially built signal generators that have a built-in sweep arrangement, the center frequency is marked on a calibrated dial. Adjustments of the plus and minus sweep frequency deviation are made by adjustment of a dial which is calibrated in frequency deviations around the center frequency.

Frequency Modulation Receiver Alignment

The alignment of frequency modulation receivers can be accomplished by the signal generator and output meter method. For best results however, the adjustments should be done with a sweep generator and oscilloscope. The heart of the F.M. receiver is the "Discriminator," and successful alignment of that stage is most easily accomplished with the aid of an oscilloscope. The i-f alignment is conventional and should be done as described above under "I-F Alignment." It is to be remembered that the bandwidth required is considerably greater than for amplitude modulation. The sweep generator must be adjusted for a plus and minus 150 kilocycle sweep.

To align the discriminator, set up the equipment as follows. Connect the generator to the signal grid and ground of the convertor tube. Use a .05 micro-farad condenser in the "hot" lead of the signal generator. With the generator frequency deviation still adjusted for 150 kilocycles as used for the i-f alignment, adjust the primary trimmer of the discriminator transformer for the greatest vertical deflection on the oscilloscope screen. Proper vertical gain control on the 'scope will be a matter of experiment but should be such to allow low output voltage from the sweep generator. The next step is to adjust the secondary trimmer until a pattern as shown in *Fig. 12-A* is obtained. This adjustment is very critical and should be made to give as symmetrical a pattern as possible. If the straight line portion of the curve in *Fig. 12-A* is not quite straight, the primary trimmer should be slightly readjusted. When this has been done, decrease the sweep frequency deviation to about 100 kilocycles. The pattern should then appear as in *Fig. 12-B*. Make a very slight readjustment of the secondary trimmer of the discriminator transformer while watching the tuning eye on the receiver. The eye should just close, but should not overlap. This completes the alignment of the i-f portion of the receiver. The r-f and oscillator are adjusted with a conventional signal generator with the equipment customarily used for aligning amplitude modulation receivers.

The sound channel of a television receiver employs an 8.25 megacycle i-f. The discriminator adjustment will be the same as above except for the use of a center i-f frequency of 8.25 megacycles instead of 4.3 megacycles as in the straight F.M. receiver or converter.

There are innumerable other uses of the Cathode Ray Oscilloscope for the service-dealer. It is believed that with the methods and material presented in this and the previous article that further uses will be made self explanatory by application of the theory and methods outlined. For those readers who wish further information on this subject, a bibliography was printed following the first article of this series in the April issue of this publication.

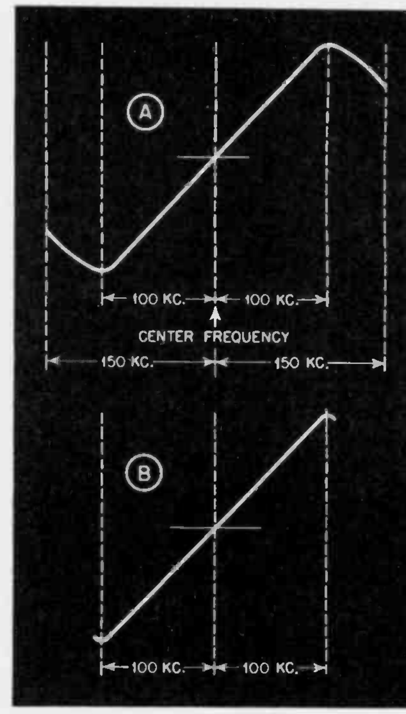


Fig. 12. Response curves for F.M. Discrimination Circuit. See text for explanation.

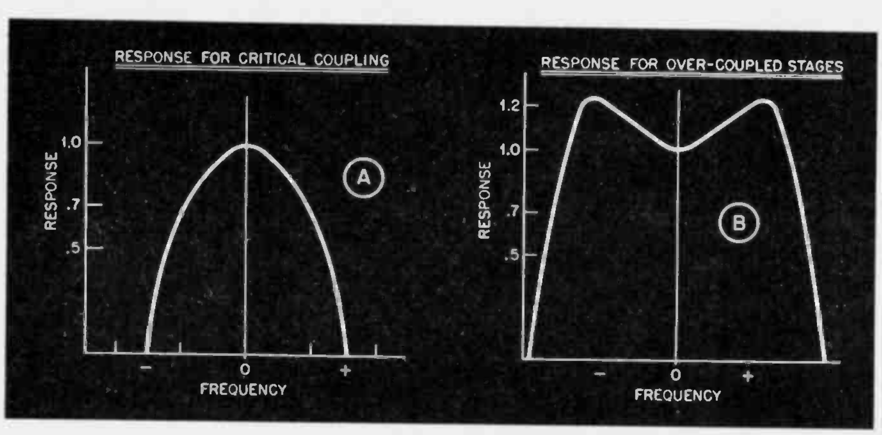


Fig. 11. I-F Response Curves.

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PARTS SALES MANAGERS MEETING FOR IMPORTANT DISCUSSION

»» A joint meeting of the Eastern Group of the Sales Managers Club, and the Western Group now known as the Association of Electronic Parts & Equipment Manufacturers, is called for the morning of June 10th, at the Palmer House, Chicago, in connection with the R.M.A. Convention.

Chairman Charles Golenpaul of the Eastern Group has accepted the suggestion of Ken Price, Executive Secretary of the Western Group, that such a joint meeting be held. In view of the recent WPB Order L-265, the setting up of the Electronic Research Supply Agency, and other current problems, all sales executives in the radio parts industry are urged to be present at this joint meeting.

Shop Notes

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

Card 1

PHILCO MODEL 39-17

(Gain Data)

Signal Analyzer, Signal Generator and Receiver tuned to 600 KC Turn attenuator on generator to high, tune receiver for dip on gain indicator—readjust attenuator to 1.0 on gain indicator through a .0002 mfd. condenser connected at the recever's ant.

Ant.		1.0	600 KC
6a7	grid	4.2	600 KC
6a7	plate	125.0 osc. freq.	1070 KC
6a7	plate	42.0 IF freq.	470 KC
78	grid	6.5 IF freq.	470 KC
78	plate	270.0 IF freq.	470 KC
75	diode plate	170.0 IF freq.	470 KC
AVC	taken at vol. cont.	7.0 volt dc	
75	triode plate	11.0 volt 400 cps	
41	grid	10.0 volt 400 cps	
41	plate	120.0 volt 400 cps	

Rock tuning condenser for all tests except for the osc. and audio.

Card 2

AMRAD MODEL F-516

(Gain Data)

Instructions: Same as given on Card 1

Ant.			1.0	600 KC
6d6	osc. mod.	grid	15.0	600 KC
6d6		plate	1400.0 osc. freq.	1050 KC
6d6		plate	840.0 i.f. freq.	450 KC
6d6	i.f. amp.	grid	100.0 i.f. freq.	450 KC
6d6	i.f. amp.	plate	840.0 i.f. freq.	450 KC
76	2nd det.	grid	460.0 i.f. freq.	450 KC
76	audio	plate	11.0 volts 400 cps	
6b5	output	grid	10.0 volts 400 cps	
6b5		plate	175.0 volts 400 cps	

Card 3

SENTINEL MODEL 240-W

Instructions: Same as above.

Ant.			1.0	600 KC
1A7GT	osc. mod.	grid	27.0 RF freq.	600 KC
1A7GT	osc. mod.	plate	12.0 osc. freq.	1055 KC
1A7GT	osc. mod.	plate	80.0 IF freq.	455 KC
1N5GT	IF amp.	grid	19.0 IF freq.	455 KC
1N5GT	IF amp.	plate	975.0 IF freq.	455 KC
1H5GT	diode	plate	730.0 IF freq.	455 KC
1H5GT	triode	plate	6.2 volts 400 cps	
1A5GT	output	grid	6.0 volts 400 cps	
1A5GT	output	plate	70.0 volts 400 cps	
AVC	at v. ctl.		3.5 volts dc	

Card 4

ATWATER KENT MODEL 487

Instructions: Same as datas 1, 2, 3, except for receiver setting, it should be tuned for *Peak* on gain indicator.

Ant.			1.0 RF freq.	600 KC
58	RF ampl.	grid	2.8 RF freq.	600 KC
58	RF ampl.	plate	1.8 RF freq.	600 KC
2A7	osc. mod.	grid	14.0 RF freq.	600 KC
2A7	osc. mod.	plate	160.0 Osc. freq.	1072 KC
2A7	osc. mod.	plate	42.0 IF freq.	472½ KC
58	IF 1 ampl.	grid	4.5 IF freq.	472½ KC
58	IF 1 ampl.	plate	300.0 IF freq.	472½ KC
58	IF 2 ampl.	grid	110.0 IF freq.	472½ KC
58	IF 2 ampl.	plate	3500.0 IF freq.	472½ KC
2A6	diode	plate	3250.0 IF freq.	472½ KC
2A6	triode	plate	17.5 volts 400 cps	
2A5	output	grid	16.0 volts 400 cps	
2A5	output	plate	60.0 volts 400 cps	

Card 5

SENTINEL MODEL 248-W

(Gain Data)

Instructions: Same as data 4.

Ant. (loop) through .1 mfd. condenser.

Ant.			1.0 RF freq.	600 KC
12SA7	osc. mod.	grid	41.0 RF freq.	600 KC
12SA7	osc. mod.	plate	125.0 osc. freq.	1055 KC
12SA7	osc. mod.	plate	260.0 IF freq.	455 KC
12SK7	IF ampl.	grid	110.0 IF freq.	455 KC
12SK7	IF ampl.	plate	5600.0 IF freq.	455 KC
12SQ7	diode	plate	2700.0 IF freq.	455 KC
12SQ7	triode	plate	12.0 volts 400 cps	
35L6GT	output	grid	11.0 volts 400 cps	
35L6GT	output	plate	120.0 volts 400 cps	
AVC	at vol. ctl.		14.0 volts dc	

Card 6

PHILCO MODEL 66

(Gain Data)

Instructions: Same as datas 1, 2, and 3.

Ant.			1.0 RF freq.	600 KC
6A7	osc. mod.	grid	3.7 RF freq.	600 KC
6A7	osc. mod.	plate	600.0 osc. freq.	1060 KC
6A7	osc. mod.	plate	100.0 IF freq.	460 KC
78	IF ampl.	grid	92.0 IF freq.	460 KC
78	IF ampl.	plate	9200.0 IF freq.	460 KC
75	diode	plate	5300.0 IF freq.	460 KC
75	triode	plate	12.0 volts 400 cps	
42	output	grid	10.0 volts 400 cps	
42	output	plate	220.0 volts 400 cps	
AVC	at vol. ctl.		30.0 volts dc negative	

These gain data submitted by Robert Boudreaux

Card 7

PHILCO MODEL 42-395

A partial short in the 18 mfd electrolytic condenser connected to the rectifier cathode will short the rectifier tube cathode to filament and burn out the power transformer. Solution, check the condenser carefully and if at fault, replace.

Submitted by R. A. Snitgen

Card 8

RCA PUSHBUTTON MODELS

(Noise and Adjustments)

When electric capacity type receivers become noisy or fail to trip properly, tap both ends of the pushbutton bakelite strips, insert 4/36" screws tightly to apply tension. Result: noise will probably be eliminated and buttons will operate correctly.

Submitted by R. A. Snitgen

Card 9

PHILCO MODEL P.T. 69

(Correcting Distortion and Hum)

Replace point 05 part #30-4519X from cathode of 7A8 to terminal of 35Z3 to antenna.

Submitted by R. A. Snitgen

Card 10

RCA MODEL V-175

(Eliminating Hum)

When ordinary methods to reduce hum have failed try removing small bias cell, checking same. If no voltage is indicated by meter, punch a small hole in the cell and force in, by means of an eye-dropper, a drop or so of water. This generally revives chemical action bringing voltage back to normal, which in turn causes hum to disappear.

Submitted by R. A. Snitgen

The Ken-Rad Tube & Lamp Corp. shows how an interesting window can be designed without much difficulty. A well-dressed window helps boost sales.

STAR FOR PHILCO STORAGE BAT. DIV.

»» For continuing excellence in production, the Storage Battery Division of Philco Corporation has been awarded a white star to add to its Army-Navy "E" flag.

The original "E" award was presented to Philco by Rear Admiral Wat T. Cluverius on October 7, 1942.

★

IRC CONTEST WINNERS ANNOUNCED

»» Several months ago the International Resistance Co. of Philadelphia launched a "Here's How" contest. Five $100 war bonds were offered as prizes to the servicemen who submitted the five most interesting answers to the questions, "How were you able to replace a volume control and get the set working satisfactorily when you couldn't obtain the volume control you would ordinarily have considered necessary for that particular make and model of radio?" IRC announces the winners—E. Pat Shultz of N. Hollywood Cal., James G. Rapp, Freeport, N. Y., Ray Pentecost, Chicago, Ill., Carl Councelman, Brielle, N. J. and W. Pelham, New Harmony, Ind.

★

IRC ADDS STAR TO "E" FLAG

»» Six months ago, when accepting the Army-Navy "E" burgee, the International Resistance Co., manufacturers of volume controls and resistors, promised "to make the Axis see stars." Employees and management fulfilled this promise for they have been awarded the white star emblematical of six months continued outstanding war production.

(From left to right) George Berry, President of Local 105 U.E.R. & M.W.A.; Harry Ehle, Vice-President of I.R.C.; Dan Fairbanks, Jobber Sales Manager and Alice Flannery, union secretary, proudly display the new white star on International Resistance Company's Army-Navy "E" Flag.

OXFORD-TARTAK UPS KOPETZKY

»» Paul H. Tartak, President of Oxford-Tartak Radio Corp., Chicago, announced the election of Alexander M. Arnt and Karl A. Kopetzky as Vice-Presidents. Mr. Arnt heads production while Mr. Kopetzky, besides continuing his executive duties, now takes charge of electronic developmental work. O-T, formerly a leading loudspeaker manufacturer has, since the war, branched out into range filters, transmitters and war required electronic apparatus.

KARL A. KOPETZKY

★

HALLICRAFTER AGAIN AWARDED

»» The Hallicrafters Co. of Chicago, who received the Army-Navy "E" last September have again been cited for continued excellence of production of communications equipment by the addition of a white star to their Burgee.

(From left to right) R. W. Durst, Marcia Davis, and Wm. J. Halligan of The Hallicrafters Co.

RESISTANCE WIRE SHORTAGE EASED

»» OWI announced, on Apr. 10th, that suppliers of fine gauge wire used in manufacturing resistors now can fill orders without delay. Hurrah! This is one of the first bottlenecks to be broken.

TUBE SUBSTITUTION CHART

4th REVISION

Discontinued Type	Replace With	Changes
00A	30	Use 2-volt filament supply
0Z3	0Z4	Use adapt. or change sock.
01A	30	Use 2-volt filament supply
01AA	30	Use 2-volt filament supply
1A1	Resistor	(a)
1A1/5E1	Resistor	(a)
1A5G	1A5GT/G	None
1A7G	1A7GT	None
1B1	Resistor	(a)
1B4	32	Bulb is larger
1B4P	32	Bulb is larger
1B4P/951	32	Bulb is larger
1B7G	1B7GT	(a)
1C1	Resistor	(a)
1C5G	1C5GT/G	None
1D1	Resistor	(a)
1D7G	1C7G	Requires higher fila. cur.
1E1	Resistor	(a)
1E2	Resistor	(a)
1E5GP	32	(b)
1E5GT	32	(b)
1F1	Resistor	(a)
1F7GH	1F7G	None
1F7GV	1F7G	None
1G1	Resistor	(a)
1G4G	1G4GT/G	None
1G5GT/G	1F5G, 33	(a)
1G6G	1G6GT/G	None
1H5G	1H5GT	None
1J1	Resistor	(a)
1J5G	1F4, 1F5G	Socket (c)
1K1	Resistor	(a)
1L1	Resistor	(a)
1LA4	1A5GT/G	Socket
1LA6	1A7GT/G	Socket
1LB4	1T5GT/G	Socket
1LE3	1E4G	Socket
1LH4	1H5GT/G	Socket
1LN5	1N5GT/G	Socket
1N1	Resistor	(a)
1N5G	1N5GT	None
1P1	Resistor	(a)
1P5G	1P5GT	None
1Q1	Resistor	(a)
1R1G	Resistor	(a)
1S1G	Resistor	(a)
1T1G	Resistor	(a)
1U1	Resistor	(a)
1W1	Resistor	(a)
1Z1	Resistor	(a)
2A3H	2A3	(d)
2A7S	2A7	(f)
2B6	6B5	(f)
2B7	6B7	(c)
2B7S	6B7	(f)
2E5	6E5	(c)
2G5	6U5/6G5	(c)
2S/4S	6H6	(c)
2Z2	82	(g)
2Z2/G84	82	(g)
3Q5G	3Q5GT/G	None
5W4	5W4GT/G	None
5W4G	5W4GT/G	None
5Y3G	5Y3GT/G	None
5Z4G	5Z4	None
5Z4MG	5Z4	None
6A4	47, 6F6	(h)
6A4/LA	47, 6F6	(h)
6A5G	6A3, 2A3	(d)
6A6X	6A6	6A6X has ceramic base
6A7S	6A7	(e)
6A8MG	6A8GT, 6A8	None
6AB5	6AB5/6N5	None
6AB6G	6B5	(h)
6AB7	7V7, 7W7	(h) (o)
6AC5G	6AC5GT/G	None
6AC6G	6B5	(h)
6AC7	7V7, 7W7	(h) (n)
6AE5G	6AE5GT/G	None
6AE5GT	6AE5GT/G	None,
6B6G	75/6SQ7	Socket
6B7S	6B7, 6B7G	(e) (h)
6B8GT	6B7, 6B7G	Socket
6C5G	6C5GT/G	None
6C5MG	6C5GT/G	None
6C7	85	(e) (h)
6C8G	7F7	(c) (h)
6D7	6J7	(e) (h)
6E6	No replacement	
6E7	6K7	(e) (h)
6F5MG	6F5/6F5G/6F5GT	
6F7S	None	
6G5	6U5/6G5	None
6H5	6U5/6G5	None
6H6G	6H6GT/G	None
6H6MG	6H6GT/G	None
6J5G	6J5GT/G, 6C5	
6J7MG	6J7GT, 6K7G	None
6K6G	6K6GT/G	None
6K6MG	6K6GT/G	None
6K7MG	6K7GT, 6K7G	None
6L6GX	6L6G	Only differ. is ceramic base
6N5	6AB5/6N5	None
6N6	6B5	(h)
6N6MG	6B5	(h)
6N7G	6N7	None
6P5G	6P5GT/G, 76	(h)
6P7G	6F7	(h)
6Q6G	6T7G	None
6Q7MG	6T7G	None
6SG7	7V7, 7W7	(h) (o)
6SH7	7V7, 7W7	(h) (p)
6T5	6U5/6G5	None
6T7G/6Q6G.	6T7G	None
6U5	6U5/6G5	None
6V6G	6V6GT/G	None
6V7G	85	(h)
6W5G	6X5GT/G	(h)
6X5	6X5GT/G	None
6Y5	6X5GT/G	(h)
6Y7G	79	(h)
6Z3	1-V	None
6Z4	6Z4/84	None
6Z5	6X5GT/G	(h)
6Z5/12Z5	6X5GT/G	(h)
6Z6MG	6X5GT/G	
6Z7G	6N7	
7A4	6J5GT/G	Socket
7A6	6H6G	Socket
7A7	6SK7GT/G	Socket
7A8	6D8G	Socket
7B4	6F5GT	Socket
7B5	6K6GT/G	Socket
7B6	6SQ7GT/G	Socket
7B7	6S7	Socket
7B8	6A8GT/G	Socket
7C5	6V6GT/G	Socket
7F7	6C8GT/G	Socket
7J7	6J8G	Socket
7N7	6F8G	Socket
7Q7	6SA7GT/G	Socket
7V7	6AC7/1852	(n)
7W7	6AC7/1852	(n)
7Y4	6X5GT/G	Socket
12A	6J5GT	(c) (h)
12A8G	12A8GT	None
12B7	14A7/12A7	None
12J7G	12J7GT	None
12K7G	12K7GT	None
12K8GT	12K8	(m)
12Q7G	12Q7GT	None
12SA7G	12SA7GT/G	None
12SK7G	12SK7GT/G	None
12Z5	6Z5	None
14A4	7A4	Fil. voltage
14A7	14A7/12B7	None
14B6	7B6	Fil. voltage
14B8	7B8	Fil. voltage
14C5	7C5	Fil. voltage
14E6	7E6	Fil. voltage
14E7	7E7	Fil. voltage
14F7	7F7	Fil. voltage
14N7	7N7	Fil. voltage
14W7	7V7, 7W7	(c)
24S	24A	(e) (h)
25A6	25A6GT/G	None
25A6G	25A6GT/G	None
25A7G	25A7GT/G	None
25AC5G	25AC5GT/G	None
25B5	6B5	Fil. voltage—Socket
25B6G	43	(c) (h)
25B8GT	12B8GT	Fil. volt.
25D8GT	No equivalent	
25L6	25L6GT/G	None
25L6G	25L6GT/G, 35A5	(c)
25N6G	6B5	Socket—Fil. voltage
25S	1B5/25S	None
25Z5MG	25Z5	None
25Z6G	25Z6GT/G	None
27S	27	(e) (h)
35A5LT	35A5	None
35L6G	35L6GT/G	None
35S/51S	35	Socket
39/44	7B7, 78	Socket
46A1	Resistor	(a)
46B1	Resistor	(a)
50Y6G	50Y6GT/G	None
51	35	None
55	85	Filament voltage
55S	85	Socket—Fil. voltage
56S	56	(e) (h)
57S	57	(e) (h)
58S	58	(e) (h)
70A7GT	70L7GT	(f)
70L6GT	25L6GT	Fil. voltage
75S	75	(e) (h)
117L7GT	117L7/M7GT	None
117M7GT	117L7/M7GT	None
117Z6G	117Z6GT/G	None
117Z6GC	117Z6GT/G	None
182B/482B	No equivalent	
183/483	No equivalent	
485	No equivalent	
950	No equivalent	
1232	7G7/1232	None
1852	6AC7/1852	None
1853	6AB7/1853	None
XXD	14F7	None
XXFM	6R7	(h)
XXL	7A4	None

Reference (a)—Use resistor or rheostat adjusted to value required to produce proper voltage across each tube filament.
(b)—Substitute is larger.
(c)—Adjust voltages to values specified in Tube Manuals for substitutes.
(d)—Make returns to 20-ohm center-tapped resistor across filament.
(e)—If oscillation results, use close-fitting type shield and ground to chassis.
(f)—Change socket connections and voltages to correspond to values specified for the substitute in Tube Manuals.
(g)—If transformer will stand 3 ampere drain. Connect plates in parallel.
(h)—Different type of socket required.
(m)—Realigning may be required.
(n)—Change plate supply voltage to 250, screen to 135; connect suppressor to screen. Add shield if 7W7 is used. Adjust cathode resistor to give —2 volts control grid bias.
(o)—Feed screen from 300-volt source through 50,000 ohms. Adjust control grid bias to —2.5 volts.
(p)—Use 300-volt screen voltage supply, feed screen through 100,000 ohms. Adjust control grid bias to —1.5 volts.

The substitutions shown on this chart are discussed in detail in the following back issues of RADIO SERVICE-DEALER:

June, 1942

1A1, 1A1/5E1, 1B1, 1C1, 1D1, 1E1, 1E2, 1E5G, 1E5GT, 1E7G, 1G1, 1G5GT/G, 1J1, 1J5G, 1K1, 1L1, 1Q1, 1R1, 1S1, 1T1, 1U1, 1W1, 1Z1, 2A3H, 2A7S, 2B6, 2B7, 2B7S, 2E5, 2G5, 2S/4S, 2Z2/G84, 6A4, 6A5G, 6A7S, 6AB5, 6AB6G, 6AC6G, 6B6G, 6B7S, 6C7, 6D7, 6E7, 6N6, 6N6MG, 6Z5, 6Y5, 6V7G, 12A5, 24S, 25B6G, 27S, 46A1, 46B1, 35S/51S, 56S, 57S, 58S, 70A7GT, 182B/482B/, 183/483, 485.

July, 1942

6C5G, 6F5MG, 6J5G, 6K7MG, 6P5G, 6P7G, 7A7LM, 6Z6MG, 6Z7G.

August, 1942

6A4, 6F6, 6A7, 6A8, 6AB5, 6G5, 6H5, 6J5G, 6K6, 6K6MG, 6N5, 6T5, 6U5, 6V6G, 7B8LM, 7C5LT, 89.

October, 1942

25Z6GT/G.

Tube Substitutions

(Continued from page 6)

ber indicates a lock-in type of base. Thus, the 1LA4, which is the same as the 1A5G, except for the loctal base; or the 1LN5, identical to the 1N5GT, except for the base. Similarly, the 1LA6 pentagrid converter can be used for the 1A7GT, so often found in battery-operated sets. And the 1LH4 for the 1H5GT diode-triode. If you haven't any more 1N5GT's, it is comforting to remember that you can use up the less called-for 1LN5's by simply changing the socket. And the 1T5GT power amplifiers may similarly be replaced with the 1LB4.

The substitutions mentioned in the foregoing paragraphs have been incorporated in the new Tube Substitution Chart reproduced on page 31. Also, insofar as possible, you will note that footnotes replace the reference to past articles discussing substitutions. We believe this will make the chart more convenient to use. As further data becomes available, the chart will be revised accordingly.

About Condensers

(Continued from page 20)

Applications by Type

To return to our circuits, let us see how important these characteristics are in specific applications. In *Fig. 3*, for instance, is shown a coupling condenser application, Rs representing the losses due to series resistance in the condenser and R_L the leakage, or insulation resistance. If we assume that the capacity of the condenser is high enough to allow signals to pass practically unimpeded, then we need consider only R_s and R_L as the important factors in the performance of the condenser. Insofar as Rs is concerned, assuming that the capacity of the condenser is 0.1 mfd and the test frequency is 1000 cycles, a power factor (actually this is the dissipation factor—which is practically the same as the power factor for low power factor percentages) of 1% would represent a resistance R_s of about 300 ohms. This is determined by the formula

Dissipation Factor (percent)
$100 \times 2\pi FCR_s$

in which the capacity is in farads and the frequency in cycles.

Since 300 ohms is negligible in comparison with the usual 0.5-meg-ohm or larger grid leak which forms the input circuit in series with Rs, there is substantially no loss in signal due to a voltage drop across Rs. However, the leakage through R_L is vitally important. If the B supply voltage is 300 and the actual voltage on the condenser is 100—a common condition—,and the grid leak Rg is 1 megohm, then the portion of the plate voltage of the previous tube will be impressed on the grid at *point a*, depending upon the ratio of Rg to Rg plus R_L. If R_L is 100 megohms and Rg is 1 megohm, it is easy to see that about 1/100th of the plate voltage, or 1 volt, will be impressed upon the grid of the following tube. Since the voltage is positive, it tends to buck the grid bias and thus renders the tube unable to deliver full output without drawing grid current and thus causing distortion. This is particularly important with power tubes having a low grid bias, and even more so when the condenser is coupling to a grid of a high-mu tube, which normally has a very low bias. In the latter case, it is good practice to use mica condensers exclusively.

In *Fig. 4*, two applications are shown, as a screen bypass and as a cathode bypass. In the former application we are no longer greatly concerned with the insulation resistance, since it serves merely to reduce somewhat the screen voltage. The series resistance of the condenser does become more important, because the effectiveness of the condenser in bypassing is dependent upon its charging current, as we have stated before, and any series resistance limits this effectiveness. This is likewise true when the cathode bypass is under consideration, though here again insulation resistance is not important insofar as the functioning of the circuit is concerned. Since Rs is tied up with power factor, it follows that a low power factor is required in both these applications.

Now that we have shown these examples and discussed them, it is easy to see that the filter applications in *Fig. 5* are similar to those just considered. Obviously Rs must be low for the condensers to be effective, while R_L is of secondary importance.

Fig. 6 shows the application to avc and detector-amplifier circuits. In the avc circuit, it is again apparent (contrary to popular opinion) that leakage is of no great importance, because no large drop will occur through R_L until the condenser becomes very, very bad—that is, until its insulation resistance is perhaps 10 megohms or less. But in the coupling application, where the grid is operated at contact-potential bias—about 1 volt—and Rg is normally 10 megohms or more, it is just as important to have high insulation resistance in the coupling condenser as in the previously discussed case. While the d-c voltage in the diode circuit to which it is coupled is low, the bias is so low and the grid leak resistance is so high that even the slightest leakage will affect circuit operation.

Applications of temperature-compensating condensers of the ceramic type are shown in *Figs. 7* and *8*. In *Fig. 7*, the fixed condensers are compensating types which shunt the coils of an i-f transformer. Small trimmers are provided to take care of aligning operations. In *Fig. 8*, the temperature-compensating condenser is shown in an oscillator circuit and serves as the trimmer, Ct.

We have devoted relatively little space to electrolytics, which constitute such a large percentage of the replacement problems. In view of their importance, we will devote a separate article to these types in an early issue.

★

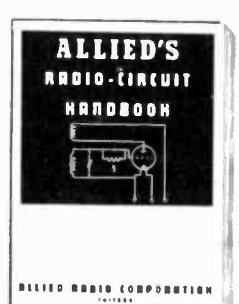
OCD ISSUES RADIO FACT SHEET

»» An interesting pamphlet called War Emergency Fact Sheet describing how radio functions in the OCD setup has been released. Copies may be obtained from the Editorial Section, OCD, Washington. Send stamped, addressed envelope.

Book Reviews

RADIO CIRCUIT HANDBOOK, published by Allied Radio Corp., 833 West Jackson Boulevard, Chicago, Illinois. Price, 10c. Forty pages, 8½" x 11".

A new publication containing radio and electronic circuits with analyses, comparisons, and discussions. The method of presentation was especially planned to make this book a useful text for the classroom and for home study as well as a reliable guide for experimenters and builders. Fundamental principles of radio are illustrated and explained in sixteen basic



circuits. The application of these principles to various components of receivers, transmitters, and other electronic units is shown in twenty-five additional circuits of conventional radio and electronic units. A schematic and pictorial diagram is shown for each unit, ranging from simple one-tube sets to superheterodynes.

This well-prepared booklet should prove to be very useful as a supplementary text for radio classes.

★

NEW TROUBLESHOOTER'S HANDBOOK, 3rd revised edition, by Alfred A. Ghirardi, published by Radio & Technical Publishing Co., 45 Astor Pl., New York City. Price $5. 744 pages, 8½" x 11". Cloth cover.

A completely revised edition designed to enable beginner and experienced technicians in troubleshooting and repairing all types of radio sets and circuits. There are 404 pages of "case histories" relating to 4,820 receiver and record-changer models; a complete tabulation of I-F peaks and alignment data; also a complete tube characteristic and basing data chart requiring 17 pages. 133 pages are devoted to specially prepared reference graphs and compilations covering information needed on substitution methods, circuit revisions, etc.

All data is arranged in a tabular, cross-indexed chart form to simplify finding wanted information. Preceeding every chart and table is an explanatory section and from the new Manual all "dead" material has been eliminated to make it more comprehensive and timely. A serviceman's library must have this new edition. FTC.

★

ELEMENTS OF PRACTICAL RADIO MECHANICS, by Samuel L. Marshall assisted by Peter Greenleaf, *published by Current Book Co., 100 Fifth Ave., New York City. 227 pages, 8½" x 11". Cloth bound edition $2.50, heavy paper covered edition $1.50.*

As the title implies this text is a shop manual for beginners. The general plan is a series of jobs arranged to enable the beginner to master essential operations and mechanics. Progressively the courses follow the instruction sheet given before each problem and at the conclusion of each contains a series of questions, which the student should be able to answer if he has absorbed the lesson.

The book is prolifically illustrated with photos and schematics and runs the entire gamut of radio theory from the Diode Receiver to Superhets. The use of test equipment is explained and concluding chapters are devoted to amplifier and transmitter circuits, microphones, multivibrator oscillators and Hartley circuits. Without doubt the authors have prepared an excellent book for students and experimenters, especially handy for anyone preparing for induction in the Signal Corps where a knowledge of radio theory is a big factor towards rapid advancement. FTC.

★

GRIMES' OPINION OF TELEVISION

»» Greatly improved by the research now going on in connection with war productions, television promises to have a greater impact on American life in the post-war years than any of the countless other applications of electronics, according to David Grimes, vice president in charge of engineering for Philco Corporation, who addressed the New York Society of Security Analysts on "The Outlook For Electronics."

"While our all-out war production program has focussed popular attention recently on some of the striking industrial uses of electronics, it appears likely that the development of television broadcasting stations and the availability of home receivers in the post-war period will have much greater effect on people's lives," Mr. Grimes said.

"Even before the war, television had been advanced to such a stage that it was possible to provide pictures of the same sharpness of detail as home movies. Through the development of successful radio links from New York to Philadelphia and Schenectady, the basis was laid for network television programs to bring outstanding entertainment and news events into people's homes over a wide area. All that will be necessary to extend the coverage to the entire nation is the erection of a large number of relay stations.

"Radio broadcasting, it will be remembered, did not reach maturity until network hook-ups were developed during the late '20s. It is significant, therefore, that unknown to most people, television has already reached this stage."

Scientific developments being rushed to completion because of the needs of the war emergency will insure the public of better television broadcasting and reception when the radio industry returns to peace-time production after helping to win the war, according to Mr. Grimes.

Referring to other important uses of electronics and the electron tube, including especially the long-distance telephone and talking movies, Mr. Grimes ventured the opinion that television in coming years would have an even more far-reaching effect than any of these on our customs and ways of life.

LITTELFUSE PROMOTIONS

»» The Board of Directors of Littelfuse Incorporated elected as Vice-Presidents: Ash Wood, Sales Manager at the El Monte, California plant, and Gerald E. Spates, General Manager of the Chicago plant. Miss Irene Mueller, Secretary to E. V. Sundt, President, was elected Assistant Secretary of the company.

Gerald E. Spates

Ash Wood

These three have long been in responsible positions with Littelfuse Incorporated, which manufactures aircraft and instrument fuses and accessories. The main plant is at 4757 Ravenswood Ave., Chicago. A large modern plant was erected and opened fully staffed at El Monte, a suburb of Los Angeles, in 1942.

★

PHILCO GETS STAR

» » In recognition of its continued war production record, the Chicago Division of Philco Corporation has just been awarded the Army-Navy "E" with a white star.

ROSIE THE RIVETER GETS COMPETITION

»» Radio frequency energy now is used to detonate explosive rivets and speed production of aircraft, E. I. du Pont de Nemours & Company states.

The radio unit assures instant control of temperature in the firing tip, eliminating time consumed in heating an electric iron to operating degrees and in frequent changes from one tip temperature to another. This method is adaptable only to large scale production. The electric riveting iron, now used widely, is still preferred for many types of work.

Explosive rivets were introduced two years ago, breaking a bad bottleneck in fastening airplane sections where riveters could work from only one side. They are installed at a rate of 15 to 20 a minute, as contrasted with two to four a minute for most "blind" fasteners.

The rivet has a high explosive secreted in a cavity at the end of the shank. Heat applied to the rivet head detonates the charge. The explosion expands the charged end of the shank, forming a "blind" head and setting the rivet.

Engineers of Radio Corporation of America and of Du Pont developed the radio unit, which consists of an oscillator together with a specially prepared applicator to concentrate current directly into the rivet head. As current is induced in the head, the heat it creates fires the charge. Radio energy not only gives instant temperature control but prolongs indefinitely the life of the firing tip. The tip is always cool, an important safety factor. The same tip can be used for any kind of rivet head.

★

DULWEBER KILLED

»» Don Noble Dulweber, well known in the radio industry as head of Supreme Instruments Corp., Greenwood, Miss., was accidently shot and killed at his home on April 5th. As he opened a closet door a shotgun that was stored there fell and discharged. Death was instantaneous.

Don Dulweber was 37 years old, the son of the late Ben T. Dulweber, businessman, banker, civic leader and former head of Supreme Instruments. Don, as everyone in radio knew him, was a charming person with very broad acquaintances. He is survived by his widow and young son.

$1.00 PAID FOR SHOP NOTES

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

G. E. PIONEERED RADAR

»» General Electric engineers as early as the early 20's were actively engaged in the development of tubes, circuits, and apparatus for the very high frequencies which form the basis for present-day radar—the electronic device which locates planes and ships far beyond man's former "vision," even in fog, darkness, and other adverse conditions—according to Dr. W. R. G. Baker, G-E vice president in charge of the company's Electronics Department. The Army and Navy recently described the radar device in a joint statement.

The United States has trained many thousands of men in the operation of radar, and will train many more thousands. Vital areas in the U. S. defense system have been equipped with the devices. Radar equipment is at work with our fighting forces on land, sea, and in the air.

In operation, radar sends out radio waves which are reflected back to sensitive receivers when a ship or plane enters the area which the radio waves cover. Returning waves are then plotted, and by a complicated system of calculations, officers determine the position, direction of travel, and speed of enemy planes or ships and then relay the information to interceptor forces.

Germany and the other Axis nations know about the device, but the Allies were the first to use and perfect its operation. It is credited with having helped save the British Isles from invasion in 1940-41 after the fall of France.

★

BELMONT'S STATUS

»» Belmont Radio Corporation of Chicago reported a net income of $330,859 for the year ended December 31, 1942. This amount was after renegotiation proceedings wherein $1,294,000 was set up for return to the government and $812,291 was allowed for Federal taxes.

1942 production, even though the highest in the firm's history, was far below the levels now being reached, due to the fact that many months of research and engineering study were required to develop the type of radio and other equipment Belmont is now making for the armed forces.

★

NEW FREQUENCY METER

»» The Fred E. Garner Co., 43 E. Ohio St., Chicago, announces four new models of their "Telrad" line of frequency meters. All models are crystal-controlled and, by means of a class "C" harmonic amplifier circuit embodied in the units, accurate frequency carrier signals are provided every 10 KC and every 100 KC from one hundred cycles to forty-five megacycles. A carrier signal is also produced every 1000 KC from one megacycle to one hundred twenty megacycles. A convenient panel-mounted "on-off" switch permits use of a 1000 cycle modulated note.

NEW UTAH VICE-PRESIDENTS

»» The Directors of Utah Radio Products Company elected Oden F. Jester, Austin Ellmore and Remy Hudson, Vice-Presidents, it was announced by Fred R. Tuerk, President of the company.

Oden F. Jester, now Vice-President in charge of Sales, has been with Utah for the past six years as General Sales Manager, and for ten years prior to his Utah connection, was with the Stewart-Warner Corporation as assistant radio Sales Manager and Radio Sales Manager.

ODEN F. JESTER

Prior to entering the radio field, Mr. Jester "grew up" with the Columbia Phonograph Company and the Brunswick-Balke-Collender Company, Phonograph Division, and his many friends in both industries will be delighted with the above announcement.

Right—REMY HUDSON
Left—AUSTIN ELLMORE

The new Vice-President in charge of Engineering, Austin Ellmore has been with Utah for the past fourteen years, Chief Engineer since 1938.

Remy Hudson, the new Vice-President in Charge of Postwar Planning, was formerly Vice-President of Mitchell-Faust Advertising Agency. Mr. Hudson's main duties will be concerned with plans for new Utah products after the war. Utah is now heavily *engaged* in war production, but the need for constructive postwar planning is fully recognized.

RENEW YOUR "RSD" SUBSCRIPTION—$2.00 for 1 YEAR

$1.00 PAID FOR SHOP NOTES

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

LAFAYETTE'S WAR ORDER DIVISION

»» To expedite orders for vital materials necessary to the war effort, Lafayette Radio Corporation of Chicago have opened a special division to facilitate prompt deliveries and procurement of war materials.

S. W. Berk and David Muir

The new division will be in charge of Mr. David Muir according to an announcement made by Mr. S. W. Berk, vice president. Mr. Muir has long been associated with Lafayette and was formerly in charge of purchases.

Mr. Berk further stated that the consistent increase of orders from manufacturers of war materials made necessary the establishing of the new division.

★

S. N. SHURE HONORED

»» At its April meeting the Association of Electronic Parts and Equipment Manufacturers (formerly the Sales Managers Club Western Group), formally presented to one of its charter members and past presidents, Mr. S. N. Shure, General Manager of Shure Brothers, a large decorated cake commemorating the recent Army-Navy "E" production award to that company. The presentation was made to Mr. Shure by Jerome J. Kahn, Chairman of the Association.

(From left to right) Kenneth C. Prince, Jack Berman of Shure Bros., S. N. Shure and Jerome J. Kahn of Standard Transformer Corp. cut cake at the Western Sales Managers Group Luncheon.

SYLVANIA UPS HEALY

»» Walter E. Poor, president of Sylvania Electric Products Incorporated, announced the apointment of F. J. Healy to the position of Vice President in charge of Operations.

Mr. Healy was formerly Vice President in charge of the lighting division. In his new post he will be responsible for all manufacturing operations in both the lighting and the radio tube divisions of the corporation.

★

HECTOR HEADS N.U. ENGINEERING

»» Dr. L. Grant Hector has joined the National Union Radio Corp., radio and electronic tube manufacturers, as Director of Engineering, it was announced by S. W. Muldowny, President.

Dr. Hector has a broad and varied background of electronic scientific research experience. He is a graduate of Oberlin College and Columbia University, has served as Physics Instructor at Oberlin, Professor of Physics at the University of Buffalo and at the time he joined National Union was engaged in electronic development work for the Office of Scientific Research and Development of the U. S. Government.

In his new position Dr. Hector will direct all electronic tube research and engineering activities for the company's laboratories and manufacturing plants located in Newark, N. J., and Lansdale, Pa.

Announcing
NEW SOLAR *Standardized* CAPACITORS *for Prompt Delivery*

For Civilian Radio Maintenance

SOLAR

"PREFERRED TYPE"

CAPACITORS

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SOLAR CAPACITOR SALES CORP.
BAYONNE NEW JERSEY U.S.A.

For Government and Industrial Electronic Applications

SOLAR

"PREFERRED-TYPE"

CAPACITORS

CATALOG No. V-2

SOLAR CAPACITOR SALES CORP.
BAYONNE NEW JERSEY U.S.A.

Memo from SYLVAN A. WOLIN

To MR. JOBBER
MR. INDUSTRIAL
MR. SERVICEMAN

Important

We think your biggest problem today is the question "What can I order, that I'll get".

To help solve this problem—to eliminate the needless confusion caused by the almost endless number of "pre-war" types—Solar presents its answer, in the form of "PREFERRED LINES FOR PROMPT DELIVERY!" For the present this is our own standardization program. Soon, it is expected that standardization will be made official for all producers.

Our new Catalogs V-1 and V-2 list a minimum number of types for a maximum number of applications. These parts can be delivered—and promptly. Buy from these catalogs and you'll eliminate most of your capacitor supply headaches.

Standardization will help every capacitor buyer, in that it will

1. Improve deliveries
2. Eliminate "back-orders"
3. Simplify inventory
4. Permit faster turnover
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