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Basic Defects In Radio Receivers

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Action

We have all heard the old proverb, "If wishes were horses, beggars would ride." This is just another way of saying that if wishing could bring success, all men would be successful.

You need only to look around you to see that wishing is not enough. The world is full of failures. But our common sense tells us that these men are not failures because they did not *wish* to succeed. So what *is* the secret of success?

It is *what we do about our wishes* that makes all the difference. The secret is ACTION. Take two men with equal ability and the one who works hardest will get ahead faster than the other man.

If one of the two men has less ability than the other, less education, fewer opportunities—but is energetic, active—does something about his problems—he will be more successful than the man who does nothing but wish for success. The men who get to the top and stay there are men of ACTION.

A certain amount of wishing is necessary and helpful. Wishing can help you chart the road to success—just as before the war, we used to take road maps and plot an automobile trip.

In order to get anywhere, however, you have to get the car out of the garage, fill it up with gas, press the starter and keep going. Yes, keep going and you will get there.

E. R. Haas, *Executive Vice President.*

Basic Defects In Radio Receivers

By D. B. LOONEY

N. R. I. Consultant

A RADIO receiver is essentially an electrical assembly of tubes, resistors, condensers, coils, transformers, a loudspeaker, switches and connecting wires. A defect in any one of these parts or wires can cause receiver trouble.

To emphasize the large number of parts which make up an average radio receiver, let us take a census of the parts in the Philco Model 41-230 a.c. superheterodyne receiver for which a circuit diagram is shown in Fig. 1. Remember that a defect in any one of these parts can produce one or more receiver complaints.

7 tubes
18 resistors
31 condensers
19 coil windings
38 socket connections
136 connections of parts
249 items total.

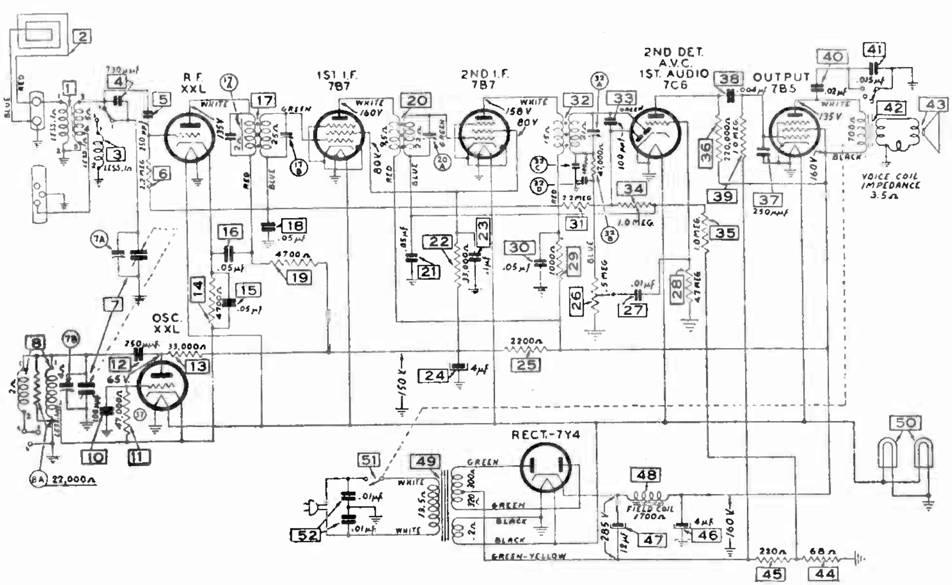


FIG. 1. Schematic circuit diagram of Philco Model 41-230 a.c. superheterodyne receiver.

But this total is by no means a true indication of the number of defects we can have in an average receiver. Take tubes, for instance—in a typical pentode tube there can be over two dozen defects.

In order to get a better picture of problems encountered in radio servicing, let us now consider in detail the various kinds of defects which can exist in each kind of radio part. We need not consider mechanical defects like broken or crushed parts, since they can be spotted readily during the initial inspection of the receiver for obvious defects.

1. VACUUM TUBE DEFECTS. A tube tester is an indispensable instrument for any radio serviceman. The following defects occur in tubes and are revealed by tube testers:

Low Emission. Inability of the cathode or filament in a tube to emit the normal number of electrons when heated is revealed by a low (BAD) reading on the meter of the tube tester.

Open Elements. Some types of tube testers will reveal open elements, but this defect can also be identified readily by the action of the circuit. An open filament is readily detected because the tube will feel cold when touched, and no filament glow will be visible. It is always wise, however, to check the tube in a tube tester, because an open in the socket or in a filament lead can cause the same symptoms.

Shorted Electrodes. These are readily detected either with a tube tester, by circuit action, by continuity tests with an ohmmeter, or by voltmeter tests.

Leakage between Electrodes. Cathode-to-filament leakage often occurs in heater-type tubes. The trouble is revealed by most tube testers, but is not in itself sufficient cause for discarding a tube. Cathode leakage does no harm when the cathode and filament are both grounded or at the same potential with respect to ground. Leakage is important only when the cathode is ungrounded.

Excessive Gas. A certain amount of gas is present in all tubes, and causes grid current to flow. Only in high-resistance grid circuits is gas objectionable, however. A voltage test across the grid resistor constitutes a satisfactory test for gas, assuming that the preceding grid-plate coupling condenser is not leaky. Gas is one defect not ordinarily revealed by tube testers.

2. SOCKET DEFECTS. Defects in tube sockets are sometimes visible on inspection, but more often a professional servicing technique is required to isolate the defect. It is quite important to realize that professional techniques are required to locate even simple socket defects such as the following:

Open Prong Contacts. Repeated insertion and removal of a tube from its socket may spread the prong contacts so much they no longer grip the tube prongs. Faulty material used in the construction of a socket will cause the same trouble. When the defect cannot be detected visually, make a continuity check between the bottom end of the suspected tube prong and its socket contact.

Shorted Prong Contacts. Shorts can occur between adjacent contacts on a tube socket, particularly if a number of wires are grouped together on the contact lugs, or if there is excessive solder. This trouble can be suspected if noise occurs when the tube is wiggled in its socket. The remedy is rearranging of connections to the socket terminals.

Leakage. Dust or a conductive greasy film on the surface of a tube socket will provide a leakage path between socket terminals, with the trouble being most serious in the case of leakage between grid and plate terminals. Brushing the socket with a small, stiff round paint brush or a toothbrush will clear up this trouble and also identify it by restoring receiver operation. Charring of the insulating material of a socket between the high-voltage plate terminal and other terminals may also cause leakage paths. Charred sockets should be replaced.

3. CONDENSER DEFECTS (PAPER AND MICA). The method of testing a condenser depends upon the nature of its defect and upon its capacity value.

Shorted Condensers. A short can occur in a condenser if a surge voltage punctures the dielectric, allowing the metal foil on each side of the dielectric to make contact. An ohmmeter will always reveal shorts in condensers. It is usually best to unsolder one condenser lead when making an ohmmeter test for a short in a part.

Leakage. This is the radio man's term for the condition whereby current "leaks" through a condenser due to a greatly lowered resistance between the condenser terminals. This lowered resistance may be the result of internal deterioration of the dielectric, or to an accumulation of conductive dirt on the surface of the condenser between the terminal leads. One condenser lead must usually be disconnected in order to make a leakage resistance check with an ohmmeter, because the leakage resistance value will be comparable to that of parts usually shunted across condensers.

There are many places in receivers where a small amount of condenser leakage is unimportant. An alert Radiotrician will recognize these and not waste time checking leakage in such locations. As an example, leakage in a condenser shunted across a cathode resistor is relatively unimportant. In other positions even a small amount of leakage is bad; thus, leakage in a grid-plate coupling condenser can cause distortion and other troubles. An alert, properly trained radio serviceman never makes unnecessary tests.

Opens. These are common both in paper and mica condensers, and occur particularly at the point where the pigtail leads are bonded to the metal foil inside the condenser housing. The most practical test for open by-pass condensers is simply to shunt each suspected condenser in turn with a good one of approximately the same capacity while the set is in operation.

Condensers having larger values, say above .05 mfd., can be checked for opens by unsoldering one lead of the condenser and checking with the highest range of an ohmmeter. A momentary deflection of the meter pointer indicates that the condenser is not open. Absence of a deflection indicates an open, provided the condenser has sufficient capacity to make the meter pointer move. Actual capacity values of condensers cannot be checked with an ohmmeter, however.

An open can often be detected by wiggling each condenser in turn while the receiver is operating; noise will occur when the defective condenser is touched. Of course, the capacity test in a condenser tester will reveal an open.

4. CONDENSER DEFECTS (ELECTROLYTICS). Electrolytic condensers perhaps require replacement more often than any other type of condenser used in radio equipment.

Wet electrolytic condensers become ineffective when not used for long periods of time. Modern dry electrolytics are much better in this respect, and will ordinarily give long life if not overloaded by excessive voltage and not dried out by excessive heat. Nevertheless, voltage surges and unusual climatic conditions will cause dry electrolytics to become defective.

Opens. These are rare in electrolytics, but high-resistance joints can sometimes occur internally at the junctions between the foil strips and the contact lugs or terminal leads, due to corrosion. Substitution of a good condenser is perhaps the most practical way to check this.

Shorts. A short will occur in an electrolytic condenser if an excessive voltage of the correct polarity is applied, or if voltage of incorrect polarity is applied for any length of time. In a wet electrolytic, the short will probably heal, but in dry electrolytics it is invariably permanent. An ohmmeter will reveal shorts.

Leakage. All electrolytic condensers have a certain amount of leakage, which is equivalent to a resistance shunted across the condenser. The leakage resistance can be measured with an ohmmeter, and will have different values depending upon the polarity of the ohmmeter connection. The leakage resistance will be larger when the positive terminal of the condenser is connected to the positive terminal of the voltage source in the ohmmeter. This is the correct connection for a check of leakage. Be sure to discharge the condenser by shorting its terminals before reversing ohmmeter leads.

An ohmmeter test gives only a general check-up of the condition of an electrolytic condenser. Better information can be obtained with a capacity tester, or by a simple substitution test. If connecting a good electrolytic in place of the suspected one clears up the trouble, you can be sure the defect has been located.

Poor Power Factor. A perfect condenser would theoretically have a power factor rating of zero, as compared to a power factor rating of one for a perfect resistor. Resistance in series with condenser capacity internally raises its power factor. A condenser with high power factor (approaching the characteristics of a resistor) dissipates energy just as a resistor does, and this produces heat in the condenser. This heat causes evaporation of the solution or chemical paste in the electrolytic condenser, raising the power factor still more and eventually drying out the unit entirely.

A condenser which feels hot to the touch is definitely drying out and has a high power factor. It should be replaced, because it will break down very soon due to the heat.

When you substitute a good electrolytic condenser and this clears up the trouble, you have identified the original condenser as defective.

5. TUNING CONDENSER DEFECTS. Gang tuning condensers in receivers are particularly susceptible to mechanical damage because they are usually entirely exposed and have moving parts. Their troubles are as follows:

Opens. The mechanical construction of a tuning condenser is such that an open in its circuit is extremely unlikely; if it does occur, it will be at the terminals and can readily be repaired by resoldering. Continuity tests between the connecting leads and the rotor and stator will reveal the trouble.

Shorts. Mechanical strain applied to the chassis during handling, warping of the frame of the gang tuning condenser, warping of tuning condenser plates, loosened mounting screws, accidental dropping of the chassis, or tampering with the gang tuning condenser can cause a short between the rotor and stator sections. You can usually identify such a condition by a scraping sound heard when the unit is rotated. To test for shorts electrically, the coil associated with the gang tuning condenser must be disconnected temporarily if it is connected between rotor and stator plates. Shorts usually occur over limited portions of the movable range. Flaky conductive materials, such as the metal plating applied to some condensers, can lodge between rotor and stator plates and cause shorts.

Leakage. The high-resistance range of an ohmmeter can be used to detect leakage in gang tuning condensers. The chief cause of this leakage is dust between the rotor and stator plates and on the insulating sections in the unit. The dust can be blown out or wiped out with a pipe cleaner of the type obtainable at any tobacco store.

Poor Contacts. High resistance at the wiping contacts in a gang tuning condenser or in the stator-mounting screws is rather difficult to measure with ordinary test equipment. If you suspect the existence of high resistance in series with a gang tuning condenser, watch for poor wiping contacts serving the rotor section. This is a frequent cause of low sensitivity and poor selectivity, and also of r. f. oscillation. These three symptoms are thus a direct clue to poor rotor contacts in many cases.

6. TRIMMER CONDENSER DEFECTS. Both the air dielectric and mica dielectric types of trimmer condensers are fortunately reasonably free from trouble. Only in rare cases will they become open, shorted or leaky, and they then require testing like any variable tuning condenser. The mica type is subject to capacity changes as a result of changes in temperature or normal aging, but this is usually easy to recognize because it affects the alignment of the receiver. The mica dielectric can crack or flake, causing changes in capacity and eventual shorting of adjacent plates.

A change in capacity is one defect which cannot be located by simple meter tests; you must be able to recognize the effects of capacity changes on receiver performance.

7. FIXED RESISTOR DEFECTS. As a general rule, low-wattage units (ranging from .1 watt to 3 watts) will be of the carbon or metallized type, and higher-wattage units will have wire-wound construction, oftentimes covered with a ceramic cement. You will occasionally encounter small 1- and 2-watt wire-wound resistors molded in a bakelite housing which resembles that of some carbon resistors, but these wire-wound units will rarely have more than about 5000 ohms resistance.

Resistors which crack or break in any way can usually be spotted visually, so we will concentrate here upon defects which can be located only by tests.

Opens. Overloading of a resistor by sending excessive current through it can burn out the resistance material or cause an open at the point where the wire lead makes contact with the resistance material. You can check for opens in resistors with an ohmmeter.

Shorts. A direct short between the two terminals of a resistor is not at all common. However, it is entirely possible for resistor leads to touch each other, to touch the chassis or touch other parts and give the same shorting effect. Also, resistors encased in metal can short to the metal case anywhere. When not visible to the eye, a short in a resistor can be located with an ohmmeter.

Changes in Resistance. Carbon resistors are particularly susceptible to changes in resistance whereas wire-wound resistors rarely change. Overloading of a carbon resistor or even continued use at normal temperatures will often cause a marked decrease in resistance, which increases the resistor current and overloads it still more. The resistance value can be checked with an ohmmeter in the usual manner. Remember, however, that carbon resistors are generally used at points where a great deal of variation in resistance value is tolerated or where the resistor is operated well under its rated wattage. Normally, variations as great as 20% in resistance value are entirely permissible.

8. VARIABLE RESISTOR DEFECTS. Variable resistors and potentiometers are far more subject to trouble than fixed resistors. Since they are mechanical in operation, we have wear in moving parts to consider. As a rule, the defect will be readily apparent because rotating of the control knob while the set is in operation will cause noise or intermittent operation. An open volume control will not provide proper control of volume even though it may permit partial transfer of the signal.

Opens. In both carbon and wire-wound controls, movement of the contact arm over the resistance element may eventually wear away the metallic or carbon deposit, or wear down the nichrome resistance wire, creating an open. Loss of spring tension in the movable arm may also give an intermittent or full open.

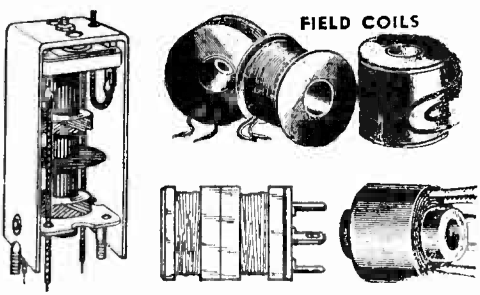
Wearing away of the resistance element reduces its heat-dissipating capabilities, so that a current-carrying control unit may be overloaded by normal current or momentary excessive current after it has worn down. This causes an open by burning out the resistance element. When the defect is not visible, an ohmmeter check will isolate the trouble.

Shorts. As with fixed resistors, shorts are not common. In units where the metal case is "hot" and an insulating bushing is used between the chassis and the mounting bushing of the control, a defective insulating washer or bushing will often create a short to the chassis. To locate a trouble of this sort, you usually have to unsolder all leads, then test between each terminal of the control and the chassis.

Change in Resistance. Wearing off of the carbon or metallized material in a variable resistor or potentiometer will cause the total resistance to increase, but this is not ordinarily of importance. The chief symptom in trouble of this nature will be noise. Manipulation of the control during the initial performance check should reveal this trouble, either by noise coming from the loudspeaker or by failure of the potentiometer to control volume or tone in a normal manner.

9. AIR-CORE COIL DEFECTS. Here we are concerned with air-core r.f. and i.f. transformers as well as with r.f. chokes. Coils consist simply of copper wire and insulation, but several types of trouble can develop.

Lowered Q Factor. A coil which becomes damp or coated with conductive dirt will develop high r.f. resistance, which has the effect of lowering the Q factor. This in turn affects the operating characteristics of the stage in which the coil is used. For example, lowered Q factor in an r.f.



A number of different manufacturers produce exact replacement coils of all types.

coil can cause poor sensitivity or poor selectivity even in a properly aligned stage, and can cause low output in an oscillator stage. The Q factor of a coil could be measured with a Q meter, but this information would be of no value unless the normal Q factor and the permissible tolerance in Q factor were known.

Inspection of the coil and temporary adjusting of resonant circuit trimmers are the usual techniques for isolating the trouble to a coil having lowered Q factor. Trimmer adjustments will be sharp for a high Q coil, but quite broad for a low Q coil. Experience in evaluating receiver performance and adjusting tuned circuits will help you to decide when a coil should be baked out or replaced because of lowered Q factor.

Shorted Turns. These may develop in all coils, particularly those employing special diamond, basket or bank windings. If a great many turns are shorted out, and the normal resistance of the coil is indicated on the circuit diagram, the defect may be detected with an appreciable reduction in coil resistance. Otherwise, the action of the circuit is the only clue to the trouble. For example, in the case of an r.f. coil in a resonant circuit, more capacity will be needed to align the receiver, and both sensitivity and selectivity will be poor even after alignment. We also have the possibility that adjacent coils may touch each other, particularly when wound close together or one over the other. Here an ohmmeter test from one coil to the other will verify the trouble.

Opens. The windings in a tightly wound coil may break due to expansion with temperature, especially at points where the wire passes through the coil form or connects to a terminal. More often, however, corrosion at a terminal will create a high-resistance joint. In a primary coil which carries the plate current of a tube, the direct current may start electrolysis which causes corrosion and an open. Noise will be the first symptom that this condition exists. An ohmmeter test will indicate above-normal coil resistance and high resistance due to corrosion at joints.

10. IRON-CORE COIL DEFECTS. Since iron-core coils are used chiefly in audio frequency and power frequency circuits, we are not concerned with changes in Q factor. Actual mechanical defects in the coil windings or failure of insulation between windings are the two chief problems here.

Opens. These are readily detected with an ohmmeter. They can be due to electrolysis, particularly at the terminals of filter chokes where fairly high currents are flowing through joints formed by dissimilar metals. Of course, a sudden voltage surge or continued overloading of a coil with excessive current may melt the wire and cause an open.

Shorts. Shorts between turns due to failure of insulation are not readily detected with an ohmmeter, but it is usually possible to detect shorts between layers of windings because this creates a greater change in resistance.

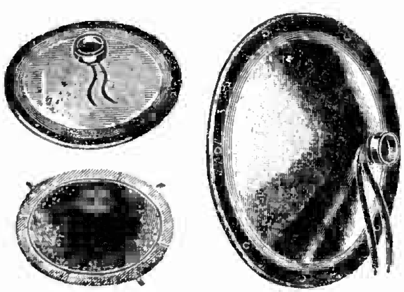
Shorts in coils are best located by their effect upon receiver operation. For example, if there is a short in a choke coil, normal current will give a lower a.c. voltage drop than normal across the coil, with hum as the symptom. A short in a power transformer will cause overheating with eventual production of smoke and charring of the insulation, and with lowered output voltage. These same effects will appear when turns are shorted to a grounded iron core and the transformer circuit is grounded at some other point, but the short to the core can also be detected with an ohmmeter.

An odor of burned insulation and a charred appearance is always an indication of a defect in an iron-core transformer. A hot unit without these symptoms does not necessarily mean a defective unit, however; a certain amount of heat is normal in transformers which are handling power. The exact amount of heat varies with different manufacturers and with different transformer uses; some transformers will operate quite cool, while others are designed to operate at the heat limit set up by the Board of Fire Underwriters.

Removal of all of the tubes is an easy way to check a power transformer for shorts; if the smoking and overheating stops when all loads are removed by doing this, you either have a broken-down filter condenser which is drawing excessive current, or you have a shorted tube or some other short to ground in a plate or screen grid supply circuit. If the smoking continues, the transformer itself is defective, or there is a short in the rectifier tube socket or in the transformer leads.

11. LOUDSPEAKER DEFECTS. In addition to becoming defective, loudspeakers are subject to normal wear and aging due to the fact that the voice coil-cone assembly is continually moving during operation. Once a defect has been isolated to the loudspeaker, you have the following possibilities to contend with:

Weak Flux. An open can occur in the field coil of an electrodynamic loudspeaker due to corro-



Exact duplicate replacement cones are made for practically all loudspeakers.

sion, electrolysis or over-loading. If the field coil is also serving as a filter choke, as is usually the case, the receiver will be dead. If there is a separate filter choke, there may be enough residual magnetism in the iron core of the loudspeaker to permit operation, but sounds will be weak and greately distorted. A simple ohmmeter check will reveal an open field coil.

Weak and distorted reception will also occur when the permanent magnet in a p.m. dynamic loudspeaker loses its magnetism. You must remember, however, that there are many other possible defects in a receiver which can produce these same symptoms. The defect should definitely be isolated to the loudspeaker before making extensive tests on the loudspeaker.

Open Voice Coil. The voice coil may open at one of its joints or in the flexible leads which connect it to the output transformer secondary. The voice coil leads are subject to breakage even though extremely flexible, because these leads must connect between fixed terminals on the loudspeaker and rapidly moving terminals on the voice coil. An ohmmeter will detect an open in the voice coil if you first disconnect one voice coil lead from the output transformer.

Grounds. You can have a ground in the field coil, the voice coil or in a hum-bucking coil. Grounds can be found by a simple ohmmeter test between the suspected coil and the frame of the loudspeaker, if inspection of the circuit diagram shows that no ground should exist.

Defective Spider. The flexible material of the spider may become brittle and crack, or may lose its elasticity. When the condition is serious, the symptoms will be a peculiar type of distortion. Visual inspection of the spider will reveal the trouble in most cases.

Sometimes the spider will get loose at the points where it is glued to the cone, causing fuzzy tones. Regluing with cone cement will fix this. Partly loosened dust caps in the center of the cone will cause the same trouble.

Off-Center Voice Coil. As a loudspeaker ages, there is usually a certain amount of entirely normal warping and shifting of parts. Rough handling can cause this same warping and shifting, and the condition becomes serious when the voice coil rubs against the pole pieces.

Iron filings, bits of metal, or hard particles of dirt lodged in the voice coil can cause the same trouble as a shifted spider or other shifted parts. You can detect a rubbing voice coil by pushing the cone in and out with your fingers when the receiver is turned off, for the vibration due to rubbing will be transmitted to your fingers, and you can hear the grating or scraping sound of the voice coil rubbing against the pole piece. The symptoms of an off-center voice coil are distortion of low notes and buzzing sounds. There is much more voice coil movement at low frequencies than at high frequencies, hence rubbing of the voice coil may distort men's voices without affecting women's voices.

Cone Defects. A cone may become hard and inflexible due to aging and drying out; the result is a rattle and failure to give normal fidelity. The outer edge of the cone, which is glued to the frame, may become loose and cause raspy, buzzing sounds and distortion at low audio frequencies. A cone may become softer than normal due to absorption of moisture, causing distortion. In a few cases the cone may actually crack or tear, causing distortion and giving a defect you can readily see on inspection. Yes, even cone defects require a certain amount of analysis for detection.

12. DEFECTIVE CONNECTIONS. Under this classification we have hook-up wire used for connecting together the various parts and tube sockets, and the tie-down terminals used for supporting small parts by their leads. A defective connection is an excellent example of a trouble which may require many minutes to locate even with professional servicing techniques, but which ordinarily can be repaired in a few seconds.

Opens. An open at a joint may be due to poor soldering at the factory in the first place. Remember that soldering, even with most modern production methods, is still a manual operation in which the human element is the predominating factor affecting quality.

As a rule, those entrusted with soldering operations in factories have had considerably more training in soldering techniques than the average serviceman, so opens at soldered joints are more likely to be present in equipment which was previously serviced. Oftentimes a soldered joint which looks good may be held together only by rosin, which is an insulator and hence causes an open. Corrosion and electrolysis at joints may cause opens, partial opens or even intermittent opens.

The procedure normally used to locate opens in wiring involves checking continuity from each tube electrode to the chassis, the rectifier plate or the rectifier cathode. Opens will then be indicated by comparison of ohmmeter readings with resistance values indicated on the circuit diagram.

Once the defective circuit has been isolated, the parts and connecting wires which make up the circuit can be checked with a step-by-step ohmmeter procedure, but more often the serviceman will simply push or pull on each joint in the suspected circuit while the receiver is in operation. The defective joint will cause noise when moved or jarred. Another favored procedure is application of a hot soldering iron to each joint in the circuit, to make the solder flow freely over the entire joint.

Shorts. Connections and bare leads sometimes short to the chassis or to an adjacent connection, particularly when terminal lugs are close together as on tube sockets and terminal strips. Where wires go through holes in the chassis, frayed insulation may allow the wires to touch the chassis and cause a short. In the case of a high-voltage lead such as a plate supply lead, sparks will be observed at the point of contact when the lead is wiggled.

Shorts may occur at joints, where the wire is bare and contact with the chassis or some other terminal is more likely. Oftentimes terminal lugs become loose or bent, or excessive solder is used in making connections at the lugs, with the result that a short exists.

When the circuit diagram indicates that a complete circuit is isolated from the chassis, a simple ohmmeter test between that circuit and the chassis will indicate whether or not a chassis short exists.

Leakage between connections is common and may cause trouble in r.f. circuits, but drying out of a moist or damp chassis will usually clear up the trouble. If it does not, new leads or parts will be required.

13. SWITCH DEFECTS. The contacts of the various switches used in radio equipment may corrode, causing opens or noisy partial opens. Loss of springiness in the movable contact arm can cause the same symptoms and troubles. In addition, connections to the switch terminals may be open, shorted or partially open.

Circuit continuity tests will usually reveal switch defects quickly. It is not at all uncommon for a movable contact arm or for a terminal lug of a switch to break off and cause an open, and here also an ohmmeter continuity test will reveal the defect.

LOCATING DEFECTS

Once the defective part in a receiver is located, any one with a little mechanical ability and a knowledge of soldering can make the necessary replacement or repair in a few minutes. The real work of a Radiotrician is locating the defective part or connection, or locating the cause of the trouble in such cases as improper alignment of tuned circuits.

When the trouble in a receiver is simply a defective part or connection, and unlimited time is available, a person with a little training in the use of a tube tester, an ohmmeter, and perhaps a condenser tester can test each part and connection in the receiver until he locates the defective one.

Of course, the chances are good that the defective part will be located long before running through the entire test procedure for all parts. But even if you were able to average 50 tests per chassis, you can readily imagine what an enormout amount of time is required when using a part-testing technique of this nature.

As a matter of fact, there are many servicemen, without the type of professional training you are now acquiring, who actually do test various parts one after another until they find the defect. With experience they learn that certain parts or connections should be checked first for each type of complaint. They become good guessers unconsciously, without knowing why, but with professional servicing techniques you can locate troubles faster than these men right from the start of your servicing career. Your techniques will work on all sets, whereas testing of parts will tell nothing at all about many kinds of receiver troubles.

n r i

N. R. I. SALUTES

Mrs. Eva Merrill

Another star in the Service Flag at N.R.I. Mrs. Eva Merrill of the N. R. I. Department of Records has joined the WAAC. Her husband is a member of the Marine Corps. The Merrill's set a fine example in active patriotism.

n r i

Save Your Copies of the News

Due to the shortage of paper, and limitations which have been placed upon publishers and printers by the War Production Board, we must order only carefully figured quantities of NATIONAL RADIO NEWS each issue.

This means it is unlikely that we can replace copies of the NEWS which are lost or damaged. Therefore, please take *especially* good care of your copies of the NEWS from now on.

n r i

Huge Television Volume After War Is Foreseen

Predicting that television will be one of the greatest of all post-war industries, reaching a volume of a billion dollars a year, Harry Boyd Brown, of Philco Corp., told a Pennsylvania State College audience last month that addition of sight to sound in Radio will be more significant than the effect sound had on sight in the moving picture industry.

Men of Science

Dr. Albert W. Hull, new president of the American Physical Society, pictured in the General Electric Research Laboratory with one of many electronic tubes on which he has made important

improvements, and which now have important war uses. The magnetron, dynatron and screened-grid tube for Radio frequency amplification are among his developments. He is assistant director of the G. E. Research Laboratory. The Society which he now heads numbers about 4,000 members, including the nation's physicists and scientists working in allied fields.

Dr. Hull has received many other honors, including the Howard N. Potts' gold medal of the Franklin Institute, awarded in 1923 for his work on X-ray crystal analysis; the Morris Liebmann Prize in 1930 for his work on electronic tubes; and the honorary degree of Doctor of Science the same year from Union University.

Born in Southington, Conn., Dr. Hull was graduated in 1905 from Yale University, where he also obtained his Ph.D. in 1909. After four years as instructor and as assistant professor of physics at Worcester Polytechnic Institute, he joined the G. E. Research Laboratory staff at Schenectady, N. Y., in 1914 as research physicist. In 1928 he was made assistant director of the laboratory.

Transformerless Power Packs

By J. B. STRAUGHN

N. R. I. Consultant

In many radio devices, more B supply voltage will be required than can be delivered by a half-wave rectifier, such as the one shown in Fig. 1. The voltage V across the input filter condenser will be equal to the peak line voltage less the small drop occuring between the plate and cathode of the rectifier tube. The peak voltage is the r.m.s. value times 1.41. This means that the greatest voltage that can ever occur across C when a standard 110-volt a.c. power line is used is somewhat less than 117 x 1.41, or 165 volts d.c. With a large input filter condenser which will not lose its charge rapidly, a low-resistance filter system and a moderate current demand from the receiver, as much as 90 or 95 volts d.c. may be delivered at the filter output.

As has been pointed out, Fig. 1 is a half-wave rectifier. Now just what does this mean—it

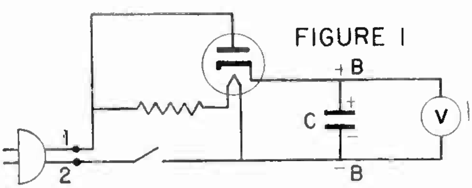


FIGURE 1

means that only half of the a.c. line voltage is being rectified. If the other half could also be rectified and placed in series with the first half, twice (double) the voltage of a half-wave rectifier could be obtained. Figure 2 shows how this may be accomplished. Two half-wave rectifier tubes (VT_1 and VT_2) are used, each feeding an input type filter condenser. When the condensers are charged, they have the polarity shown and their voltages will add together. If condensers C_1 and C_2 are equal in capacity, the voltage across each will be equal and the sum of their voltages will be double that expected from a single half-wave rectifier. For this reason, Fig. 2 is known as a voltage doubler.

A clear understanding of the circuit action may be obtained by tracing the flow of current through the circuit. If a complete circuit exists, electrons will flow from point 2 when it is negative, and an equal number of electrons will flow into point 1. This is a fact with which you are familiar. Now let's trace out the actual path. We see that there are two possible paths, C_1-VT_1 and C_2-VT_2. However, electrons cannot flow from a plate to a cathode, so the C_2-VT_2 path is blocked. Electrons instead flow into the negative plate of condenser C_1, and an equal number are forced out of the positive plate. This charges condenser C_1 with the polarity shown. The electrons leaving the positive plate of C_1 flow from the cathode of VT_1 to its plate and on to point 1, completing the circuit.

When the a.c. line voltage reverses, electrons leave point 1 and, finding their way blocked by VT_1, pass through VT_2 and charge C_2. Those

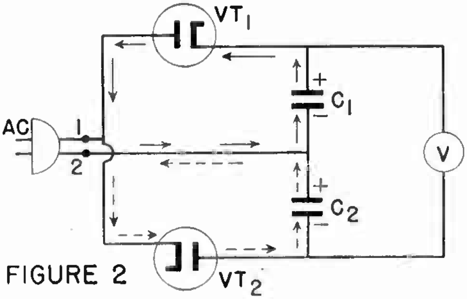


FIGURE 2

electrons driven off the positive plate of C_2, during the charging process, flow to point *2*. The solid arrows show the direction of current flow when point *2* is negative, while the dotted arrows indicate the direction of current flow when point *1* is negative.

Figure *2* is a simplified circuit, and an actual circuit using two half-wave diodes in a single envelope and showing a regular filament string appears in Fig. *3*. This circuit looks complicated but, in its important details, it is the same as the simple circuit in Fig. *2*.

Resistors R_1 and R_2 have a value of about 30 ohms each, and are placed in the diode plate leads to avoid the possibility of damage to the tube cathodes due to excess peak currents. Resistor R_3 is the series filament voltage-dropping resistor, and VT_1, VT_2 and VT_3 are the filaments of the tubes being supplied with power.

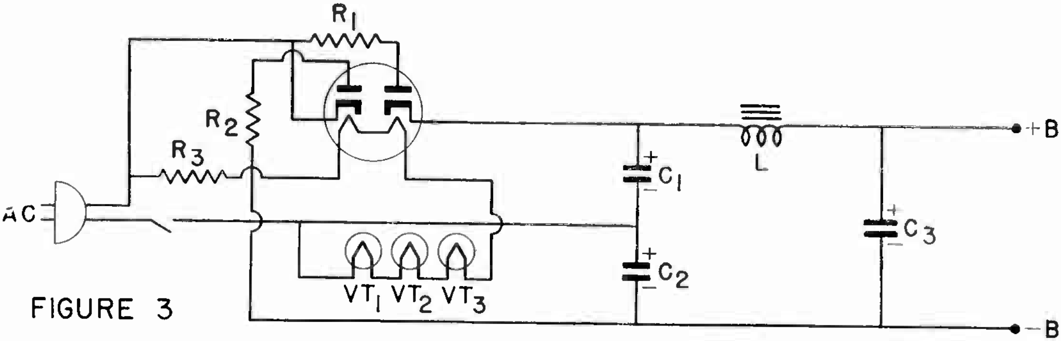


FIGURE 3

Notice that the filament of VT_1 connects to the positive side of condenser C_2. The cathode of VT_1, along with those of VT_2 and VT_3, connects to —B and to the negative side of C_2. This places the voltage of C_2 across the heaters and cathodes of all the receiving tubes. The excellent heater-to-cathode insulation used in modern tubes prevents a great deal of leakage trouble. To reduce the voltage, C_2 is sometimes made smaller than C_1. This can only be done where the receiver will operate at reduced B supply voltages. Since C_1 and C_2 are alternately being charged from the power line, we have in effect full-wave rectification, and the ripple across the two condensers will have a frequency twice that of the line—120 cycles in the case of a 60-cycle line.

The Half-Wave Voltage Doubler. In order to avoid the situation just described, where the voltage across C_2 in Fig. *3* is applied between the heaters and cathodes of the receiving tubes, a voltage doubler in which —B connects to one side of the power line would be required. In considering how this may be accomplished, refer back to Fig. *1*. Here we have a half-wave rectifier which charges a condenser. This charged condenser will act as a source of d.c. voltage, slowly discharging into any load that is connected to it. Current flows through the tube when point *1* is positive, and ceases when point *2* becomes positive. At this time the voltage between +B and point *1* is the condenser voltage plus the line voltage. Half the sum of these voltages is a.c., existing only for one half cycle. If another rectifier tube is used, this a.c. half cycle can be put to work. The circuit in Fig. *4* shows how this may be done. Tube VT_1 and condenser C_1 correspond to the tube and condenser shown in Fig. *1*.

When point *2* is negative, electrons flow from point *2*, into and out of C_1, and through VT_1 to point *1*. On the reversal of the a.c. line voltage, C_1 retains its charge and the voltage acting through C_2 on the plate-cathode of VT_2 is that across C_1 plus the voltage between points *1* and *2*. Point *1* is negative and point *2* is positive, so for this half cycle it is just as though we had two d.c. voltages in series. The plate of VT_2 is made highly positive with respect to its cathode, and electrons leaving point *1* flow into C_2, forcing other electrons out of the + terminal of C_2. These pass through VT_2 and are forced into the positive terminal of C_1. An equal number of electrons are forced out of the negative terminal of C_1 (C_1 is being discharged) and travel to point *2*, thus completing the circuit. When the line voltage reverses, current flow through VT_2 ceases and VT_1 becomes conductive, recharging C_1. Since VT_1 only conducts every other half cycle, the frequency of the a.c. ripple across C_2

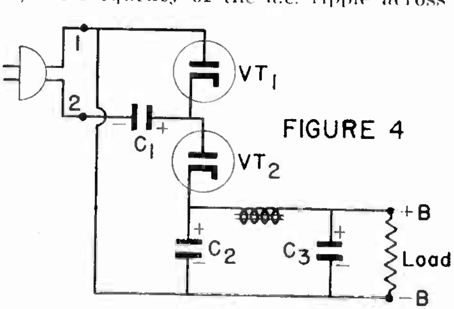


FIGURE 4

is the same as the power line—60 cycles for a 60-cycle line. Thus the circuit in Fig. 4 is a half-wave voltage doubler and a better filter than is

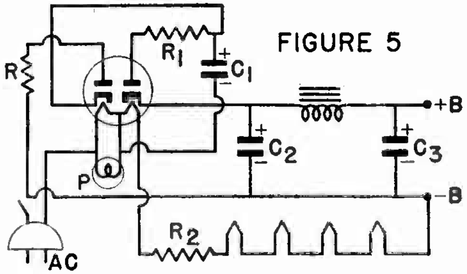


FIGURE 5

used with the full-wave doubler will be required to eliminate the ripple.

Condenser C_2 is charged to the voltage of C_1 (minus the drop in VT_1) plus the peak a.c. line voltage (*minus the drop in* VT_2). With no load we can expect about 300 volts across C_2. The voltage drops to about 180 volts in the average receiver.

Figure 5 shows a complete half-wave voltage doubler. Condensers C_1, C_2 and C_3 correspond to condensers C_1, C_2 and C_3 in Fig. 4. Resistors R and R_1 protect the diodes against excess peak currents, while R_2 is the filament voltage-dropping resistor. Note the pilot lamp P shunted across half of the rectifier tube filament. The filament string connects directly across the a.c. line and to —B. Therefore, there is no large d.c. voltage between the heaters and cathodes.

While condensers C_1 and C_2 in Fig. 3 could be rated at 150 volts d.c., we must use a condenser with a higher working voltage at C_2 in Fig. 5. This condenser should have a working voltage of at least 300 volts d.c. Condenser C_1 may be rated at 150 volts d.c., since a greater voltage than this is never applied across it.

Vibrator Power Supplies

D.C. to A.C. In an automobile, boat or aeroplane, the only voltage source is a low-voltage storage battery of 6 to 12 volts. This battery is kept charged by a low-voltage d.c. generator. The battery voltage is too low to be directly applied to the plates and screens of tubes, so some way must be found to raise the voltage of this source to the proper value. Anyone who had not studied the fundamentals of radio might say, "just use a step-up transformer."

What would happen if we were to connect a storage battery to the primary of the power transformer shown in Fig. 6A? When the circuit was first closed, current would start to flow through the primary and the resultant change in flux linkage would induce a large voltage into the secondary as shown in Fig. 6B. The current would gradually rise until it reached its maximum value, determined by the resistance of the wire with which the transformer was wound. The current would then remain constant until the circuit was broken. The secondary voltage would drop to zero and stay there since voltage will only be induced when there is a change in flux linkage.* When the primary circuit is opened, the current will cease flowing and the magnetic field will quickly collapse. This will cause another change in flux linkage, this time in the opposite direction, and a secondary voltage pulse as shown by the dotted lines in Fig. 6C will appear.

From this, you can see that d.c. can be stepped up with a transformer and changed into a high a.c. voltage if the primary circuit of the transformer is opened and closed fast enough with a switch. This allows the d.c. to flow in pulses which rise from zero to maximum and then decrease to zero again, something like the current pulses delivered by a half-wave rectifier. Of course, if we could make the d.c. reverse in the primary, we would get more a.c. secondary pulsa-

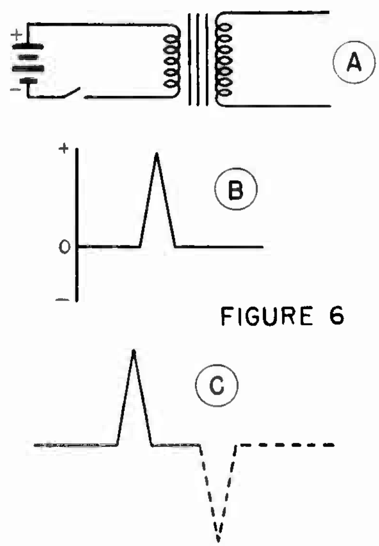


FIGURE 6

tions, closer together, and whose average value would be greater. Figure 7A shows how this can be done. Note that the primary is center tapped, one battery terminal connecting to this tap and the other battery terminal connecting to a switch arm which alternately connects to first one outside primary lead and then the other.

When the switch is thrown to the position shown, the current flow in the primary is indicated by

Also, the primary current would probably become great enough to burn out the primary winding.

the solid arrow. The direction of the current induced in the secondary is also shown by a solid arrow. Throwing the switch up results in primary and secondary currents whose directions are indicated by dotted arrows. Solid and dotted lines also show the wave shape of the primary current and secondary voltage in Figs. *7B* and *7C*.

The secondary voltage shown in Fig. *7C* could be rectified by either a half or full-wave rectifier and passed through a filter to produce a high d.c. voltage. The sharpness of the positive and negative peaks would make the filter job difficult, and the sparking at the switch contacts each time they were opened would soon ruin the switch. Connecting a condenser across each switch contact would stop the arcing and give a smoother

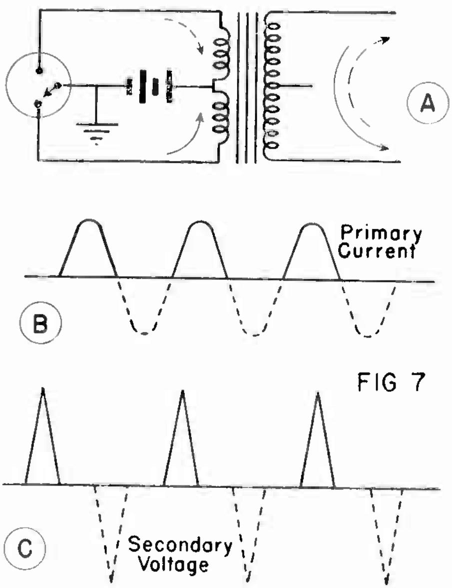


FIG 7

wave shape, but such a condenser would have to be very large in capacity. Just as good results are obtained by connecting a small high-voltage condenser called a buffer condenser across the secondary, as shown in Fig. *8A*. Note the improvement in the wave shape shown in Fig. *8B* over *7C*, now it resembles the voltage delivered by a transformer operated from an a.c. power line.*

**The buffer condenser capacity is quite important and is chosen to work with a particular transformer and a certain rate of switch closure. When replacing a defective condenser, use the capacity and working voltage originally employed by the manufacturer.*

In Fig. *8A*, the switch is a thin metal reed *R* with two contacts K_1 and K_2. This reed vibrates up and down, closing first K_1 and then K_2.

Vibrator Motors. The reed-type switch is typical of those found in actual use and it only remains for us to see how the reed may be caused to properly vibrate back and forth. To drive the reed, we use a "motor," something like the buzzer of an electrical doorbell. Two types of "motors" are used—the shunt type and the separate driver type.

Figure *9A* shows the separate driver type, the motor section being shaded. Here the vibrating reed is indicated by a heavy line, and this reed is quite springy. Normally, contacts *K* and K_2 are closed. Then current flows through the electromagnet *L* and contact *K*. This energizes the electromagnet and the reed is pulled up to it, opening contacts *K* and K_2, and closing contact K_1. The electromagnet is now no longer energized and exerts no pull on the reed which returns to its normal position. Current again flows through *L*, and the cycle of events repeats itself as long as the battery is connected. The period of vibration of the reed is dependent on its mechanical characteristics: *i.e.*, its length, springiness, etc. The secondary buffer condenser not being in the motor circuit cannot stop the arcing at *K* when it opens, so a separate condenser *C* across *K* is used. This contact, like the others used in vibrators is large, having a flat surface area and is made of a hard grade of tungsten to reduce wear to a minimum.

The shunt type of motor does not require a separate contact and is more widely used. Its circuit is shown in Fig. *9B*. Normally, both con-

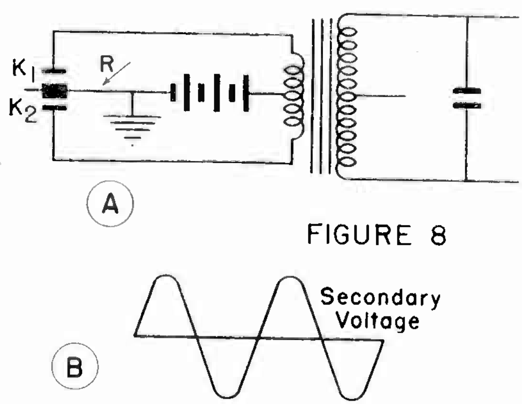


FIGURE 8

tacts are open and when the switch *SW* is closed, current flows through the chassis, shown by ground symbols, electromagnet *L* and primary winding P_1. The electromagnet being energized pulls up the reed, closing contact K_1 and in

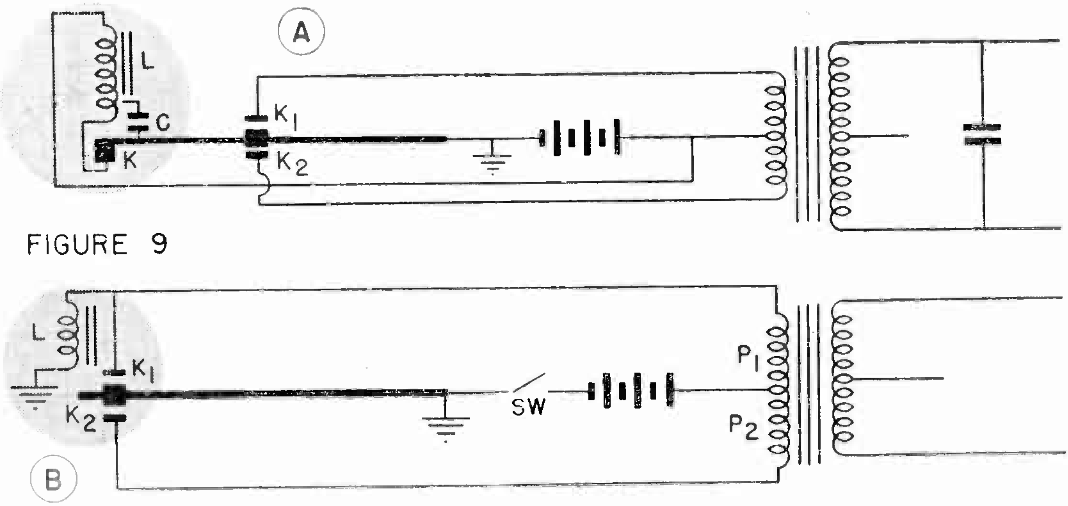


FIGURE 9

effect connecting the battery across primary P_1. This, however, shorts coil L and current flow through it ceases. The reed springs back towards rest, but over-shoots the mark and closes K_2. Of course, when K_1 is broken, the current again starts to flow through L and it soon builds up enough magnetic pull to jerk the reed back to close K_1. This cycle of action is repeated as long as on-off switch *SW* is closed. Of course, we always have current flowing through P_1 (it flows through L when K_1 is open), but this does not have any appreciable effect on the wave form of the secondary voltage.

Rectification. We have seen how a high a.c. voltage may be obtained from a d.c. source, and it now remains to consider the means commercially employed for rectification of this a.c. voltage. Naturally, you at once think of a full-wave tube rectifier and such a method is often used. Figure *10* shows a typical circuit. The only real difference between this and an ordinary power pack is that the filament of the rectifier tube is supplied from a battery. This calls for good insulation between the cathode and heater, for as much as 400 volts may exist between them. Also, the voltage pulses which result from rectification are still rather sharp and the process of rectification increases the r.f. hash interference. R.F. filters in the rectifier filament, power transform-

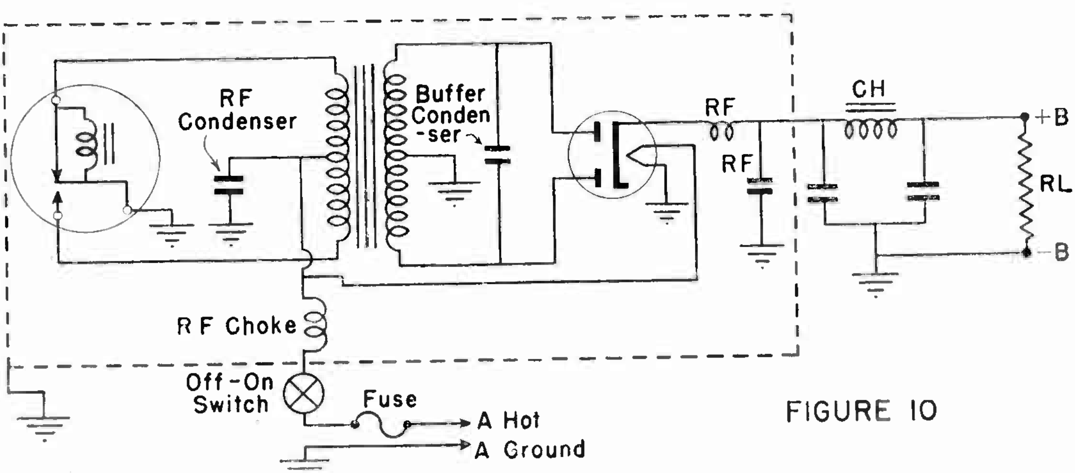


FIGURE 10

er and B+ supply leads prevent this hash, as it is called, from being fed to the other tube circuits. Direct radiation is prevented by complete shielding, as shown by the dotted lines. Notice that the two battery leads are marked A-hot and A-ground. The one marked A-ground connects to the grounded side of the battery. As far as the power pack is concerned, it makes no difference whether +A or —A is grounded.

If the filament current drawn by the rectifier tube

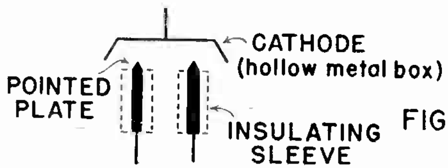


FIG. 11

could be eliminated, this would result in a worth while saving in battery power and for this reason, cold cathode rectifier tubes are sometimes employed in auto radios. To refresh your memory, refer to Fig. *11* which shows the structure of a typical cold cathode rectifier of the full-wave type. These tubes are filled with gas which, on ionization, become an excellent conductor. Rectification is due to the physical structure employed which allows the positive plates to jerk electrons out of the large cathode area which is exposed. When the applied a.c. voltage reverses, making the cathode positive with respect to a plate, the "pull" exerted by the positive cathode on the now negative plate is applied to only a small surface area and, as a consequence, we have only a comparatively small current flowing at this time in the undesired direction. In other words, the cold cathode tube is a two-way conductor but with conductivity far better in one direction than another.

The ionization of the gas in the tube results in a brilliant purplish glow which is continually flickering with changes in current through the tube. The cold cathode tube has a serious disadvantage in that it is a prolific source of r.f. interference which creates hash. It is far worse in this respect than the mercury vapor tube which it resembles. Often where this interference develops, it is difficult to eliminate it due to aging of the filters, poor joints at shield contacts to the

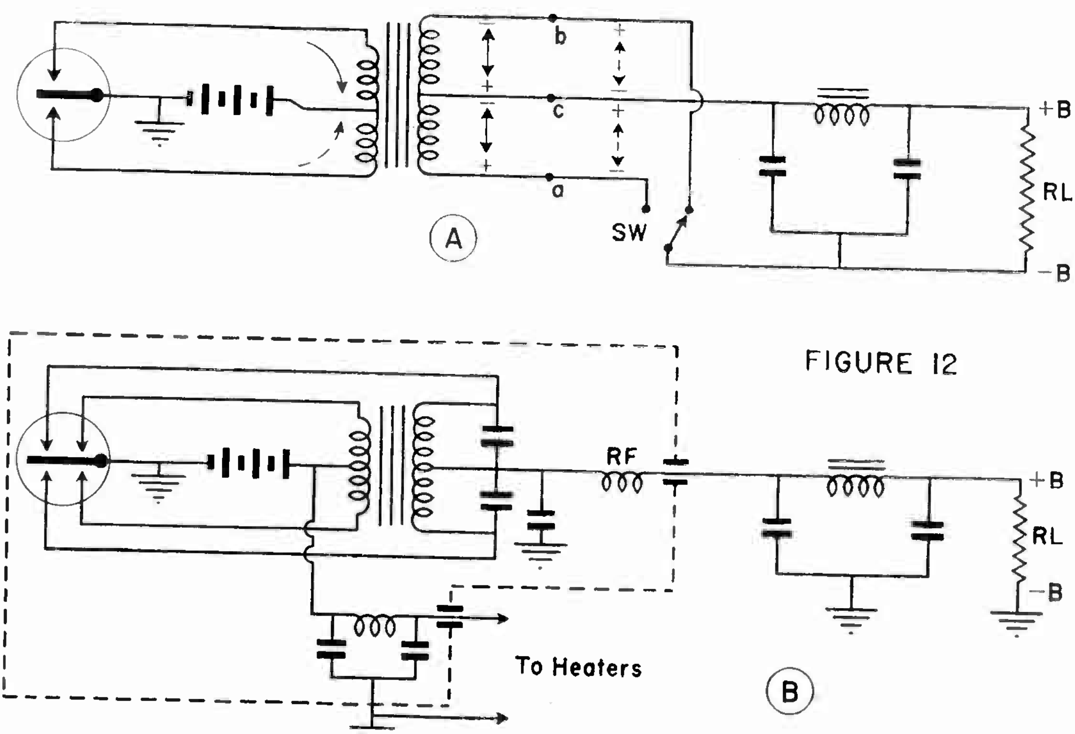


FIGURE 12

chassis, etc. In such a case, a serviceman will usually rewire the circuit for a heater-type rectifier. In most cases, it is only necessary to wire in the filament circuit, retaining the original tube socket.

The Synchronous Vibrator. In Fig. *12A* we have another scheme to rectify the high a.c. secondary voltage. When current flows through the primary, as shown by the solid arrow, the secondary voltage polarity will be as shown by the solid arrows drawn between the secondary terminals. Current flow through the other primary half causes a reversal of secondary voltage polarity, as shown by the dotted arrows.

Notice that at all times, the center tap *C* on the secondary will be positive with respect to either *a* or *b*. If *b* is negative and we connect it to —B, the voltage *b-c* which has the correct polarity will be applied to the load. When the secondary voltage reverses, point *a* is connected to —B and will apply voltage *a-c* through the filter and to the load. Again the polarity will be correct. Ordinarily —B and the switch arm would just connect to ground. Here the ground connections are omitted so you can see that when a ground on —B is used the fact that the A battery is also grounded is simply a coincidence.

In a system of this sort, you can see the importance of synchronizing switch *SW* with the changes which occur in the secondary voltage. These polarity changes are caused by the vibrator reed switch in the primary. By just adding two extra sets of contacts to the reed assembly, we can switch the secondary connections in time with the a.c. voltage variations. Systems of this sort are in common use and the vibrators are appropriately called synchronous vibrators. Figure *12B* illustrates the circuit. The motor unit has been omitted for simplicity, but either type already described may be used. The same shielding precautions required with the tube type rectifier are used, and an r.f. filter is necessary in the +B and filament leads. The chief advantages of this system lie in the battery current saving, achieved by the absence of a rectifier tube and the saving of space. This is very important where space is at a premium, as it is in mobile equipment.

While vibrator systems are most often found in cars, small boats and planes, they are also used in some farm receivers and may operate from a 2 to 6-volt storage battery, or from a 32-volt farm lighting plant. In the latter case, the receiver tube filaments are generally wired in series as in an a.c.-d.c. receiver. The vibrator system of changing d.c. to a.c. is at times used to change the 110 volt d.c. power line voltage found in some sections of our large cities to 110 volts a.c. at 60 cycles. This makes it possible to operate standard 60-cycle a.c. equipment from a d.c. power line.

Radio Helps Maintain Flow of Electricity

(From March 1, 1943 issue of Public Service News)

Application of Radio to the electric power industry consists of a system of control whereby electric trouble is located automatically and prevented from spreading and shutting off power. Public Service utilizes this application of Radio.

Radio sets, in terms of the electric industry, are not to be confused with the type in the home. The set is connected to a high voltage substation bus and with its associated equipment is as tall as an ordinary two-story house.

The set has no antenna, in the usual sense, but is connected to the high voltage transmission lines by means of special devices. The Radio waves are not broadcast into the air in all directions in the usual manner, but are guided or "carried" by the high voltage conductor to which the set is connected. Hence the term "carrier current" is applied to this particular application of Radio. Usually all of this equipment is located out-of-doors, and is housed in weatherproof containers made of porcelain and steel.

The manner in which these carrier current Radio sets operate to maintain electric service is comparatively simple. One set is located at each terminal of a high voltage transmission circuit, similar to those seen on the countryside. These bare conductors of electric power are exposed to the elements; to such adverse phenomena as sleet formation in winter, which sometimes causes the conductors to slap together, or to the dangers of lightning in summer. When these occur, the transmission line no longer passes its electric power freely through its conductors. Large concentrations of power are stopped where the trouble has occurred and unless corrective measures are taken immediately, an entire power system may be placed in difficulty. This is called a short-circuit.

During the moment of short circuit, practically no electricity can reach the home and lights grow dim. It is at this point that Radio plays its major role. Instantly, every "carrier current" Radio set in the system is thrown into operation. The sets closest to the trouble recognize this fact and permit the protective relays to operate and trip the circuit breakers.

This disconnects the short-circuited line and allows power to pass freely over the rest of the system. All Radio sets on other lines, at the same time, prevent the other circuit breakers from being opened.

The entire protective system operates at high speed. The short circuit is located by the "carrier current" Radio within one-sixtieth of a second, and the entire trouble cleared from the power system, automatically, in less than one-fifth of a second.

Sample Questions and Answers for Radio Operator License Examinations

By WM. FRANKLIN COOK

N. R. I. Technical Consultant

THIS is another installment of the questions taken from the "Study Guide and Reference Material for Commercial Radio Operator Examinations," together with typical answers. The questions give a general idea of the scope of the commercial radio operator examinations.

The basic theory for these questions has been covered elsewhere in your Course, but is being repeated here as answers to these questions. Remember, the following answers are far more detailed than would be required for an operator's license examination. The questions are theoretical, so the answers go more thoroughly into the basic theory, in order to permit similar questions to be answered.

Some of the material is advanced technical data, of course, which can be properly understood only by the advanced student or graduate. However, you will find this information valuable, whether or not you intend to take the operator's license examination.

ELEMENT II

Basic Theory and Practice

(2-113) Draw a simple schematic diagram to indicate how a 60-cell bank of lead-acid storage batteries may be connected to permit charging in parallel from a 110-volt d.c. source and discharging in series, including necessary switches.

Ans. A 60-cell lead-acid battery has a voltage of 126 volts, as each cell has 2.1 volts. In order to charge this battery from a 110-volt source, we must arrange for splitting up the cells into groups. In other words, when the cells are connected in series, the battery voltage is greater than the 110-volt charging source voltage. Therefore, the batteries will have to be put in parallel groups and charging resistances used to lower the line voltage to the amount required for charging each group. A 4-pole, double-throw switch will do the job as shown in Fig. 2-113.

When the switch is thrown to the right, the cells are connected in series, and are then connected to the circuit which they are to operate.

Storage battery arrangements of this type are very commonly used in emergency

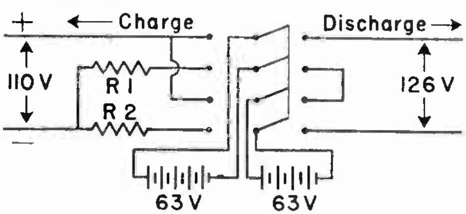


Fig. 2-113

installations, particularly on board ships. The d.c. power line normally operates the radio equipment by running motor-generators. In an emergency, the storage battery operates the same motor-generators.

Be sure to notice the fact that this is a d.c. power line being used to charge the batteries. We cannot use a.c. directly to charge batteries. If an a.c. line were available, we would have to rectify the a.c. to obtain the necessary d.c.

(2-114) Draw a diagram of a simple shunt rejector or wave trap circuit, in series with the receiving antenna circuit, designed to suppress an undesired signal.

Ans. See Fig. *2-114*. The circuit is a parallel resonant circuit, placed in series with the antenna lead-in. This circuit offers a very high impedance to its resonant frequency, so it is tuned to the offending station frequency. The incoming signal voltage at this particular frequency will divide between the wave trap and the input impedance of the radio. Due to the high impedance of the wave trap, most of the energy is dropped across the impedance of the wave trap, leaving less for the radio, so this trap tends to reject the frequency to which it is tuned. The impedance of the trap drops rapidly on either side of resonance, so it has but little effect on other incoming frequencies.

(2-115) Draw a diagram of a simple series wave trap circuit connected in shunt with the input terminals of a radio receiver and designed to by-pass the undesired signal.

Ans. Refer to Fig. *2-115*. This time a series resonant circuit is used, connected across the antenna and ground terminals of the radio receiver. When tuned to resonance, the series resonant circuit offers practically zero impedance. Hence, it will act as a short circuit to the frequency to which it is tuned. This tends to by-pass this particular frequency around the input circuit of the radio.

At other frequencies, the impedance of the circuit is appreciable, so the normal path for signal current is again through the antenna coil of the radio.

These two questions are very similar to question *2-57*.

(2-116) Draw a simple schematic diagram of an underload circuit breaker as used with battery-charging circuits.

Ans. There is some doubt as to the exact type of relay which may be required for this question. Figure *2-116* shows several types of relays which may be found in charging circuits.

At *A*, an *underload* relay is shown. To start the current, the relay is closed manually (by hand). This completes the circuit, so current flows through the relay causing it to hold itself closed. As the battery is charged, the current flow becomes less since

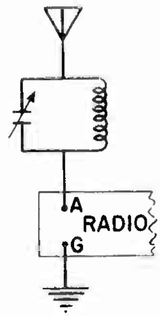


Fig. 2-114

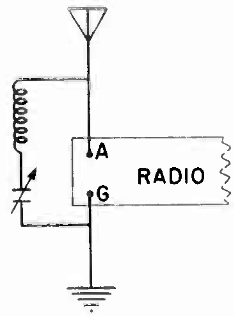


Fig. 2-115

the battery voltage approaches the generator voltage. When the current falls below the amount needed for the relay to hold, the armature will drop out, thus breaking the circuit.

B shows an *undervoltage* relay. This relay will close the circuit only after the generator voltage rises to the amount required for charging the battery. Once closed, the battery voltage would tend to keep it closed unless it is very critically adjusted. Hence, this relay is normally used with a reverse current relay as shown at *C*.

The double relay shown at *C* is the type usually found in charging circuits. Relay coil *1* is the undervoltage winding. When the generator voltage rises enough to charge the battery, this coil closes the relay. The current flow through winding *2* now assists in keeping the relay closed. However, should the generator voltage drop below the battery voltage, the battery will discharge through the generator. This current flows in the reverse direction through winding *2*,

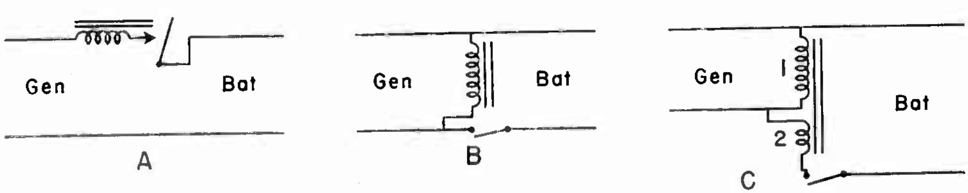


Fig. 2-116

which causes its field to reverse and oppose that of coil *1*. Hence, the relay opens, protecting the generator. This device is entirely automatic in operation.

The familiar cut-out used on automobile generators is a device of this type. The relay is called a reverse current cut-out although it also contains an undervoltage coil.

(2-117) Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be one-third of one unit.

Ans. It is not necessary to draw this diagram. The resistors are of equal value and there are three of them. Connecting three equal resistors in parallel will give a resistance one-third the value of one resistor. Hence, the three resistors are just connected in parallel.

(2-118) Draw a simple schematic diagram of a shunt-wound, self-excited, d.c. motor with provision for starting and regulating speed, including indication of d.c. source.

Ans. See Fig. *2-118*. The motor is a shunt motor because the field is in shunt or in parallel with the armature winding.

The starter consists of a tapped resistor unit which is in series with the armature. When the motor is standing still, there is no back e.m.f. so a very high current would

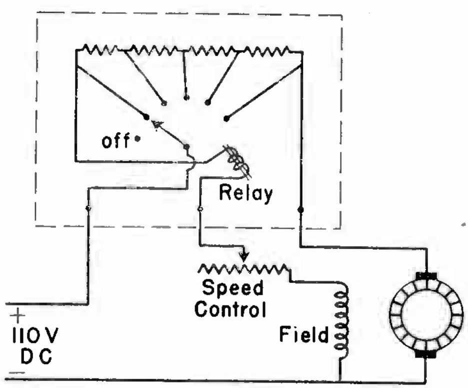


Fig. 2-118

flow if the connection is made directly to the power line. Therefore, the starter is advanced step by step, gradually decreasing the series resistance as the motor comes up to running speed. The actual final speed is then controlled by the variable resistor in series with the field, which changes the field voltage.

There is a relay in the starting box which holds the switch arm on the running contact as long as the field is excited. Should anything happen to open the field winding, the motor would tend to run away, particularly if operating with no load at the moment. Therefore, if the field opens, this relay releases the controlling arm of the starter, allowing it to return to the "off" position through the action of a spring. The motor is thus automatically protected against open-field trouble.

(2-119) Draw a simple schematic diagram showing the method of connecting three resistors of equal value so that the total resistance will be three times the resistance of one unit.

Ans. Again no drawing is really necessary. You know that resistors in series add to each other. Since we must have three times the resistance of one unit, and have three resistors, we must connect the three of them in series.

(2-120) Draw a diagram of a single-button carbon microphone circuit, including the microphone transformer and source of power.

Ans. See Fig. *2-120*. As shown, the microphone is connected in series with the primary of the microphone transformer *T* and a small battery. The carbon microphone works on the principle of a varying resistance. In other words, movement of the diaphragm compresses small carbon granules when it moves in one direction and releases pressure when it moves in the other. This causes varying contact resistance between these small particles. There must be a source of voltage in series with the microphone so that the current will be varied by this changing resistance.

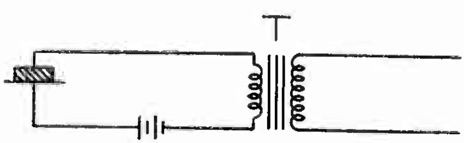


Fig. 2-120

The voltage can be adjusted to a suitable amount by either changing the number of cells or, in some instances, by having a series variable resistor.

The microphone transformer is designed to match the impedance of the microphone to a transmission line or to the grid circuit of a tube.

(2-121) What is meant by a "soft" vacuum tube?

Ans. This term is used to describe a tube which does not have a high degree of vacuum. This usually means that a certain amount of gas remains in the tube.

(2-122) What is meant by a "thyratron"?

Ans. A thyratron is a high-voltage rectifier tube, with the addition of a grid-controlling element. The tube uses a filament, so has a hot cathode. A negative bias on the grid element will prevent plate current from flowing in this tube. When the bias is removed or changed according to some controlling impulse, the tube will become conductive. The tube is a mercury vapor type and the high degree of ionization results in the grid losing all control over the plate current as long as the plate is maintained at a positive voltage. If an a.c. voltage is applied to the plate, then the grid can resume control by being made negative at a time when the plate voltage is zero. Thus, the tube can be used as a rectifier tube to produce pulses of current of a predetermined time duration. The tube is widely used in industrial control equipment.

(2-123) Describe the physical structures of the triode, tetrode, and pentode on a comparative basis.

Ans. A triode tube consists of a cathode, surrounded by a control grid, which in turn is surrounded by the plate element.

The cathode can be the filament itself, or the filament can be used to heat a separate cathode. The grid element is either a fine wire mesh or a spirally-wound wire. The plate may be a metal mesh, a solid metal plate, or in transmitting tubes, may be made of carbon or some similar material. These elements are supported by mica, glass and other insulating beads, spacers and washers. The unit is then contained in a glass or metal envelope.

The tetrode tube resembles the triode except for the addition of another grid element between the control grid and plate. This grid element is usually a spirally-wound wire element, maintained at a positive potential.

A pentode is similar to the tetrode, with the addition of another grid between the screen grid and plate. This extra grid is known as the cathode grid because it is usually maintained at cathode potential.

These three basic tube types vary considerably in regard to spacing between the elements, size of elements, amount of emission, and other electrical characteristics.

(2-124) Describe the electrical characteristics of the pentode, tetrode, and triode on a comparative basis.

Ans. Triode tubes normally have rather low plate resistances and a comparatively low amplification factor. The plate resistance may range from 500 to 50,000 ohms, and the amplification factor normally is somewhere between 3 and 100. When used in radio frequency stages, the triode requires neutralization.

The tetrode tube has a considerably higher plate resistance and amplification factor. Both these characteristics depend on the screen grid voltage, however. The plate resistance may range from 20,000 ohms to higher than 1 megohm, while the amplification factor may range from 50 to 1500.

Tetrode tubes were originally developed as radio frequency tubes because they did not require neutralization and had much lower inter-electrode capacity. Several types intended for audio amplifiers have been developed. When these audio types are used in radio frequency amplifiers, however, they may require neutralization as they are not as efficiently shielded as are the regular radio frequency types. The extremely high plate resistance makes it impossible to get more than a small percentage of the total amplification from such tubes, but even so, stage gains are many times higher than that obtained with triode tubes.

Pentode tubes are very similar in characteristics to tetrode tubes. They have the additional advantage of eliminating secondary emission from the plate to the screen when the plate voltage happens to drop to a value below the screen grid voltage. This permits large plate voltage swings without distortion which would be common in tetrode tube stages.

(2-125) What are the visible indications of a "soft" tube?

Ans. Since a soft tube contains a certain amount of gas, there usually will be a blue haze between the elements of the tube. Since this gas ionization may tend to increase the plate current, you may find that the plate of the tube will become red, even though normal plate voltage and the grid bias are applied.

Transmitting tubes are normally run with the plate at a red heat, so a check of the operating voltages and plate current is the surest indication of a soft transmitting tube.

(2-126) Describe the physical structure of a triode vacuum tube.

Ans. Refer to the answer to Question 2-123.

(2-127) Describe the physical structure of a tetrode vacuum tube.

Ans. Refer to the answer to Question 2-123.

(2-128) Does a pentode vacuum tube usually require neutralization when used as a radio frequency amplifier?

Ans. This depends on the type of pentode. If the tube is intended for radio frequency purposes, it does not require neutralization. However, if an audio type pentode tube is being used in a radio frequency stage, then neutralization may be required as the shielding is not as efficient in audio type tubes.

Further, if the stage is being used as a frequency multiplier, such as a doubler or tripler, neutralization is usually not required.

(2-129) What is the meaning of "plate impedance"?

Ans. The plate impedance of a tube is the operating or dynamic impedance between the plate and cathode inside the tube. It is equal to the a.c. plate voltage divided by the a.c. plate current. This tube rating changes with operating voltage changes.

(2-130) What is the meaning of "mutual conductance"?; "transconductance"?

Ans. These two terms mean the same thing. The mutual conductance can be found by dividing the amplification factor of a tube by the plate resistance. It is also found by dividing the plate current change by the change in grid voltage which produced the plate current change, providing the other operating voltages remain constant. This term is sometimes known as the "figure of merit" of the tube. This is true because a drop in the amplification factor or an increase in the plate resistance, due to aging, results in a lower stage gain. This is indicated by the mutual conductance dropping off.

(2-131) What is the meaning of "secondary emission"?

Ans. Secondary emission means the emission of electrons from some element other than the cathode, due to electron bombardment of that element. This emission is usually from the plate element, although it can also occur from any of the grids. It is caused by electrons striking the element at such a high speed that other electrons are knocked out of the element itself.

(2-132) What is the meaning of "amplification factor"?

Ans. The amplification factor of a tube may be defined as the ratio of the plate voltage change to the grid voltage change, necessary to produce the same plate current change. (Usually given as $d\ E_p \div d\ E_g$, where "d" indicates "the change in.") This ratio indicates how much more effective the grid is than the plate in controlling plate current. This is the measure of the ability of the tube to act as an amplifier.

(2-133) What is the meaning of "electron emission"?

Ans. Electron emission is the act of emitting or releasing electrons. This emission may be the result of an external force, such as a voltage, or may be the result of heating the electron emitting object. The latter is the most common method encountered in radio tubes.

(2-134) Describe the characteristics of a vacuum tube operating as a class C amplifier.

Ans. A class C amplifier is a stage in which the grid bias is considerably greater than the amount necessary for plate current cut-off. No plate current will flow until a signal voltage large enough to swing the bias more positive than the cut-off value is applied to the grid. As a result, current can flow only on the positive *peaks* of the signal applied to the grid. Due to the operating point being well beyond the cut-off bias point, plate current can flow only for a period appreciably less than ½ cycle. If 1 cycle is considered to be 360°, ½ cycle will be 180° (electrical degrees). Class C amplifiers normally have operating angles of approximately 135° to 150°.

(2-135) During what approximate portion of the excitation voltage cycle does plate current flow when a tube is used as a class C amplifier?

Ans. Refer to the answer to question 2-134. Plate current flows for less than ½ cycle, or during an operating angle of 135° to 150°.

(2-136) Describe the characteristics of a vacuum tube operating as a class A amplifier.

Ans. A class A amplifier is one in which the bias voltage is fixed so that the tube operates on the straight portion of its characteristic curve. Plate current flows at all times. Normally, the signal applied to the grid of the tube is limited so that operation is maintained over the straight portion of the tube characteristic curve. This provides linear amplification, relatively free of distortion.

(2-137) Describe the characteristics of a vacuum tube operating as a class B amplifier.

Ans. A class B amplifier is one in which the bias voltage is set at the point of plate current cut-off. Plate current will flow during the positive swing of the grid excitation voltage. Therefore, plate current flows for ½ cycle or during an operating angle of 180°. When no excitation is applied to the grid, the plate current is essentially zero.

(2-138) During what portion of the excitation voltage does plate current flow when a tube is used as a class B amplifier?

Ans. See answer to question 2-137.

(2-139) Does a properly operating class A audio amplifier produce serious modification of the input wave form?

Ans. No. If the class A amplifier is operated properly, the operation will be limited to the straight portion of the tube characteristic curve. Hence, the plate current change will be practically an exact copy of the grid voltage swing. Thus, the full cycle is reproduced with a minimum of distortion.

(2-140) What is the meaning of the term "maximum plate dissipation"?

Ans. Whenever plate voltage is applied to a tube stage, power is dissipated in that stage. The total amount of power is equal to the plate voltage multiplied by the plate current.

Part of this power is converted into useful signal power and is dissipated in the plate load. The rest is dissipated inside the tube, in the tube plate resistance. The power which is used up or dissipated within the tube itself depends on the efficiency of the stage. There is a definite limit to the amount which a tube can safely dissipate without overheating and melting the elements within the tube. The value which is the maximum safe value for a particular tube is known as the "maximum plate dissipation" rating. The circuit efficiency and operating voltages must be adjusted so that this value is not exceeded.

(2-141) What is meant by a "blocked grid"?

Ans. A blocked grid is one which is so biased or negatively charged that plate current is cut off. This condition can occur through the application of a high value of bias, and will also occur when the grid circuit is open. In the latter case, the charge trapped on the grid causes the blocking.

(2-142) What is meant by the "load" on a vacuum tube?

Ans. The load is the device in the plate circuit of a tube, used to transfer the signal to the next stage, or which uses the signal power directly. This device represents the impedance into which the tube works.

(2-143) What circuit and vacuum tube factors influence the voltage gain of a triode audio frequency amplifier stage?

Ans. The amplification of a radio stage is determined by the amplification factor of the tube and by the relative values of the tube plate impedance and the load impedance into which it works. When transformer coupling is employed, the gain is determined by the amplification factor of the tube and the turns ratio of the transformer.

(2-144) What is the purpose of a bias voltage on the grid of an audio frequency amplifier tube?

Ans. In an a.f. stage, the bias voltage is used to place the operating point of the tube on the straight portion of the characteristic curve, at a point where there will be a minimum amount of distortion. The bias must be adjusted so that it is sufficiently negative to prevent the grid ever becoming positive, yet must not be so negative that negative signal swings will cause operation over a curved portion of the tube characteristic.

(2-145) What is the primary purpose of a screen grid in a vacuum tube?

Ans. The screen grid is a shield between the control grid and the plate in a vacuum tube. Its purpose is to eliminate or substantially reduce the grid-to-plate capacity in the tube.

(2-146) What is the primary purpose of a suppressor grid in a multi-element vacuum tube?

Ans. The suppressor grid is used to prevent the flow of secondary emission electrons from the plate to the screen grid. Due to electron bombardment, the plate will emit electrons. These electrons can go to the screen grid, particularly if the signal swing is such that the plate voltage is low at the moment. As this reversed current flow is undesirable since it produces distortion, the suppressor grid is placed between the screen grid and plate. By making the suppressor grid negative with respect to these elements (by connecting it to the cathode), it will repel the electrons so that they return to the plate element.

Novel Radio Items

—BY W. R. MOODY—

A new Western Electric sound analyzer makes it possible to detect weak heart action of employees in a chemical explosive plant and to prevent the possibility of an explosion that might injure a number of men and wreck the plant if the worker should happen to faint while handling explosive elements.

—*n r i*—

The use of high-frequency electromagnetic fields in the future will be of great importance in medical, industrial and research work. As an example, a new and very valuable use for high-frequency heating is the prevention of a $250,000,000 yearly stored grain loss due to insects. The grain is passed between two electrodes which carry a 3.5-megacycle current. In fifty seconds, the temperature of the grain is raised to 130° Farenheit and all four life stages of the insects are killed.

—*n r i*—

Research into the problem of starting an aircraft engine in low temperatures—sub-zero—has indicated that rather startling conditions are present. For example, a 24-volt battery delivers only 4 volts at 20° below zero.

—*n r i*—

An electronic device that indicates the thickness of ice formed on airplane wings at high altitudes and which automatically operates de-icing mechanisms incorporated in the leading edges of wings has been developed, weighs less than five pounds, takes up less than 200 square inches of space. De-icing equipment is turned on at the exact instant it is needed. The equipment consists of three separate units, sensing element, amplifier and relay mechanism.

—*n r i*—

If you could put a billion, billion, billion electrons on a scale, they would weigh less than an ounce, since they are so inconceivably small. More than two million, million, million pass a given point in the filament of a 100-watt lamp in one second. The mass of an electron with respect to an atom of hydrogen is comparable to the mass of an ordinary chicken's feather as the feather is to the earth.

—*n r i*—

A General Electric photoelectric spectro-photometer, which distinguishes two million shades of color, is being used in an Army Air Force laboratory for studying the art of camouflage.

Use of a new electronic instrument eliminates the hazard of a man carrying high static charge working around explosives in a refinery or repairing a gas main.

—*n r i*—

A magnetic-type pickup, having a diaphragm which is exposed to the explosion or pressure forces within the cylinder of a Diesel or gas engine, provides an output voltage having identical characteristics to the high pressures developed within the cylinder. The vibration of the diaphragm produces magnetic flux variations in the coil. The coil is connected to an oscilloscope and the electrical wave form of the pressure is observed by the engineer.

—*n r i*—

A radio beam scale now makes it possible for the blind to play an important part in war production by weighing certain materials such as powder for fuses, mica for radio mechanism and buttons for uniforms.

—*n r i*—

A newly-designed "pancake" Diesel engine weighs one-fifth as much, and takes only one-third of the space of any previous ocean-duty Diesel of the same horsepower. Developed by General Motors, the new engine provides Navy sub-chasers with increased speed, longer cruising radius. Diesel engines drive electric generators which charge storage batteries. Radio equipment depends upon the battery power.

—*n r i*—

B. F. Goodrich is now able to manufacture tires of relatively low-electrical resistance, using a rubber compound of high-carbon black content. Electrostatic charges on airplane tail wheels, collected in the air, will now leak off to ground when the planes land. This prevents shock to passengers, also prevents development of sparks that could cause gasoline explosions. The new rubber compound is applicable to other machines which collect static charges.

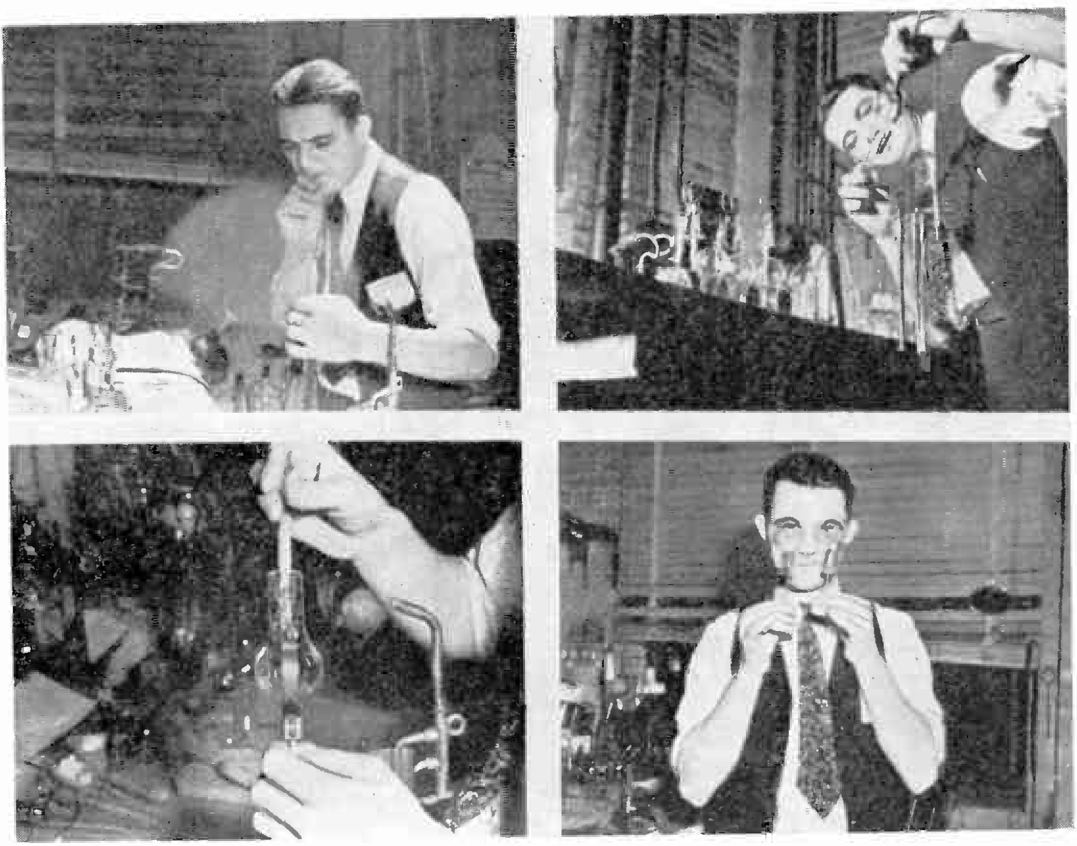
—*n r i*—

Using the electroencephalograph, a Yale University scientist has been able to measure electrical brain waves. The microvoltmeter used is so delicate that two weeks' time is required for its adjustment.

MAKING AN "ELECTRIC EYE" TUBE

One of the most popular and versatile of the electronic tubes is the popularly known "electric eye" tube which has gone to war, helping to detect saboteurs trespassing on forbidden grounds, detecting pin holes in sheet steel used to make cans for food, turning out store and other lights during air raids, and has a host of other practical applications.

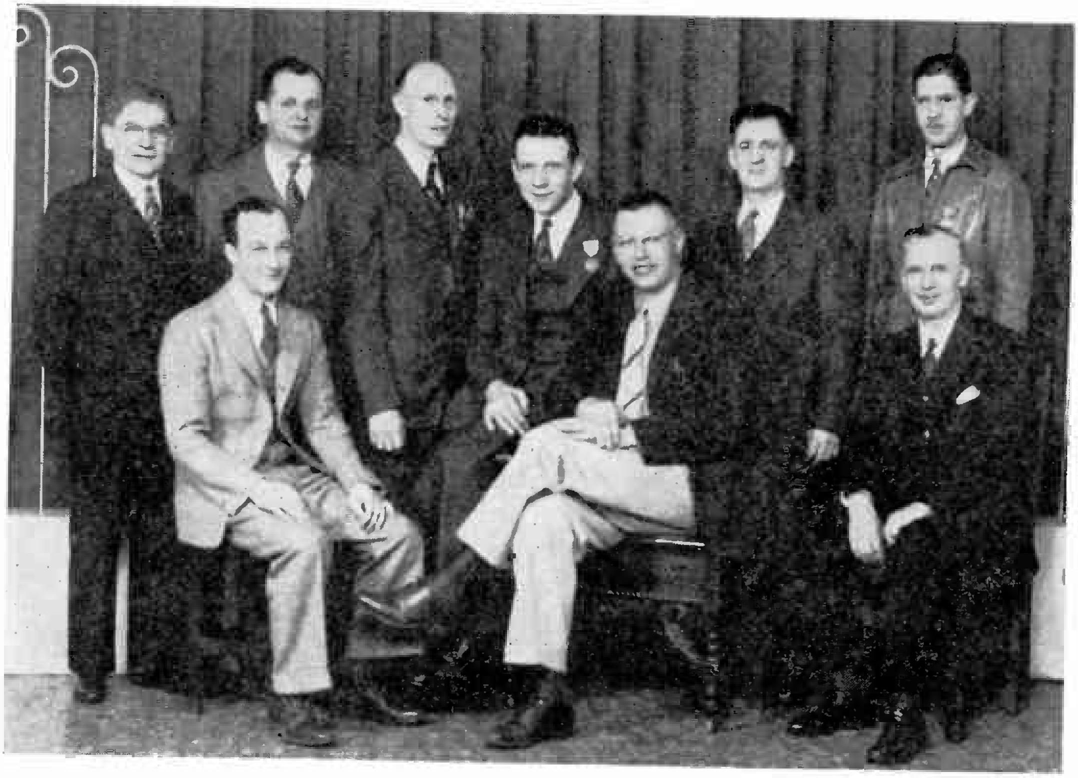
In the following four pictures, E. J. Greeley, veteran glass blower of General Electric's research laboratory, is seen making an "electric eye" tube. In the upper left picture, Greeley blows a glass envelope for the tube. The glass begins to soften at 800 C, roughly the temperature of a gas burner on a kitchen stove, and is worked at around 1000 C. In the upper right view, Greeley reams out the base of the glass envelope to permit insertion of filaments. Lower left view shows the insertion of filaments into the phototube. Whether the tube will be sensitive to visible or invisible light depends on the metal used for these filaments and the kind of glass in the envelope. Caesium, sensitive to visible light, is the most common metal used. In the lower right picture, Greeley holds two "electric eyes" before his own. They are ready to be exhausted, aged and based.



N.R.I. ALUMNI NEWS

F. Earl Oliver .... President
Peter J. Dunn .... Vice-Pres.
Louis J. Kunert .... Vice-Pres.
Earl R. Bennett .... Vice-Pres.
Chas. J. Fehn .... Vice-Pres.
Earl Merryman .... Secretary
Louis L. Menne .... Executive-Secretary

PHILA-CAMDEN CHAPTER OF N. R. I. ALUMNI ASSOCIATION HAS STRONG LEADERSHIP



Left to right, seated: Harold S. Strawn, Former Secretary; Norman Kraft, Past Chairman; Bert R. Champ, Chairman; L. L. Menne, Executive Secretary, on visit. Standing: Edward B. Ferguson, Entertainment; James Sunday, Librarian; Chas. J. Fehn, Treasurer and National Vice-President; John McCaffrey, Financial Secretary; and Harvey Morris, Vice-Chairman. These men are doing big things for Phila-Camden Chapter.

MEET YOUR ALUMNI BROTHER

SENATOR HOYT MOORE, INDIANA

In the Fall of 1929, seventy-five N.R.I. graduates met in Washington for a convention to celebrate the fifteenth anniversary of the founding of the National Radio Institute.

At this convention, the N.R.I. Alumni Association was organized. Officers were elected. Mr. Hoyt Moore, of Indianapolis, Indiana, was elected a Vice President. It is not important here to mention the other officers elected at that time. This story is about Hoyt Moore, Charter Member and former Vice President of the N.R.I. Alumni Association.

Always a gifted speaker, it was fitting that Mr. Moore should be chosen to make the presentation speech when the Alumni Members gave Mr. J. E. Smith a beautiful loving cup at the banquet which closed the 1929 convention. This loving cup, presented to Mr. Smith to commemorate the occasion, is thirty-six inches high, cast in silver, with a cover surmounted by a statue of Victory, symbolic of the prestige of the National Radio Institute in the field of Radio education. The cup is engraved with the name and state of residence of each Charter Member of the Alumni Association.

Senator Hoyt Moore

Almost fourteen years have passed since Mr. Moore attended that auspicious convention, yet he has never lost contact with N.R.I. He has always had a warm spot in his heart for his Alumni Association brothers and frequently exchanges letters with his friend Mr. J. E. Smith.

It was with great joy and pride that we learned, early this year, that Mr. Hoyt Moore had been elected a State Senator to represent Marion County in the Indiana legislature. The sterling character which we, at N.R.I., recognized in Mr. Moore as far back as 1929, has won for him the deep respect of his constituents who have elected him to this high public office.

Mr. Moore is a man who has built his reputation on his rugged honesty. In 1932, writing for the N.R.I. Alumni Association Year Book, he emphasized the fundamental principles upon which he won the full confidence of his neighbors when he said, in part: "This Alumni Association Year Book will fall into the hands of many young men who have not yet had an opportunity to profit by experience. To them, then, let this be considered as friendly advice.

"But this book will also be read by many of my brother Alumni Association Members who have every bit as much experience in the Radio profession as I have—possibly more. To this latter class, my article is intended as a reminder—a recalling of principles, of ideals.

"We are the first and perhaps only association of the Alumni of a home-study school. Since we own that distinction let our Association be individual in the fact that we, as a body, built our businesses on the principle of the square deal . . . Bigger firms than any of us may ever reasonably expect to own, claim that the one secret in the success of their business was in the slogan that the customer is always right.

"I have alway made it a policy never to charge a cent unless my customer was absolutely thoroughly satisfied. Surely I've lost money in some cases. But let us be thankful that the great majority of the American public is honest and loves fair play. Instill confidence in your customer; answer his questions frankly; be strictly honest in all your dealings with him. . . .

"It will be found that good, conscientious service at a reasonable charge makes the greater profit in the long run. Let every one of us, in the N.R.I. Alumni Association, operate our business on lines of proper service and proper charge. Let's give our public a square deal."

That is the philosophy that has carried Hoyt Moore to the front as a Radio man and into the halls of the Senate of the great State of Indiana. "Give our public a square deal." That is exactly what the people of Indiana are getting from Senator Hoyt Moore. He will never fail them. We, his Alumni brothers, are proud of him. May he go on to even greater deeds and earn greater honors.

Here and There Among Alumni Members

For the many fine letters and reports regarding activities of local chapters—for the time given to preparing them in spite of difficulties and press of time—for the loyalty and interest of officers and members we want to express our deep appreciation.

—n r i—

Chas. F. West of San Francisco has been operating his Radio business for ten years and is going bigger than ever right now. He is one of the best known Radio men in the city of the Golden Gate.

—n r i—

Charles Burch is Chief Engineer at Radio Station WHUB, Cookeville, Tenn. He expects to qualify for a commission in the Marine Corps, in the Aircraft Warning Service.

—n r i—

John Patrizi of Newark, New York tells a true story about a woman who, determined to get a Radioman quickly, phoned to say her Radio was on fire. Actually she wanted a new tube.

—n r i—

Arnold H. Green of Massachusetts is now a Lieutenant, Signal Corps, U. S. Army.

—n r i—

We are sorry to learn that Stephen D. Woodland of Camden, N. J., passed away. We sympathize with Mrs. Woodland and hope she has recovered from her illness resulting from her great grief.

—n r i—

Paul Howell is Radio service man for Western Auto Associate Store in Columbia, Tenn., at a salary of $60.00 a week. Started earning after 10 lessons and got his first full time Radio job after 20 lessons. Was smart enough to keep on studying until he graduated and now is well on the road to bigger money in Radio.

—n r i—

Antonio M. Rosario is with the Federal Communications Commission in Puerto Rico.

—n r i—

Not so many months ago, Irving Wort, of the N.R.I. family, answered the call to the colors. Starting as a private he won several promotions. The other day he paid us a surprise visit sporting the uniform of a Lieutenant. Nice going, Lieutenant Wort.

—n r i—

Comes a letter from Mrs. Ruth Ramond Thomas telling us her husband, and our Alumni brother, Henry Webb Thomas, is on duty with a bombardment squadron in North Africa. No doubt he has already seen plenty of action.

—n r i—

R. B. Asbill of Modesto, Calif., graduated six years ago. Has built up a grand business known as City Radio Service and now clears about $500 a month. Nice income!

—n r i—

Meade Mellott is working for Douglas Aircraft on B-17's inspecting Radio Equipment in Final Assembly.

—n r i—

Miss Jule Shelton, the receptionist at N.R.I. has joined the WAVES. The folks here presented her with a handsome wrist watch and other gifts. A lot of Alumni members who met this pleasant little lady will want to join us in extending our very best wishes to her.

—n r i—

J. B. Cason, Jr., of Florida had a nice job as Radio Mechanic, civilian, in the Signal Corps but had to resign and return home because of the serious illness of his father. Now doing very well in his full time radio business.

—n r i—

Joseph P. Wilson of Chicago, Ill., is in the Radio Division, Air Force, as a tower operator.

—n r i—

V. Elmo Hill has completed the greater part of the operators course given by the U. S. Coast Guard. Found his N.R.I training a valuable aid.

—n r i—

M. Sgt. Thos. B. Love is home to see his family in Texas after two years of service in Alaska and the Aleutians. Has been ill and feels a visit at home is just the tonic he needs to return him to active duty.

—n r i—

Alumnus F. Connor of Valleyfield, Que., Canada has two sons, both in the Army. One has been overseas for two years—the other, fresh out of high school, joined the Air Force.

—n r i—

Robert M. Bond who is a Radio Operator in the Merchant Marine sends greeting to all Alumni members. Says he is getting his share of adventure and likes it.

—n r i—

N.R.I. men are in there pitching for Uncle Sam—and how! Another is Lucien M. Petit who is a Radio Technician in the U. S. Army Air Corps.

Philadelphia-Camden Chapter

Heretofore we have been meeting at Freas Shop. The Air Raid Warden Service was sharing these quarters with us but on separate dates for meetings. However, we never knew just when an air raid practice alarm would come and a number of times, in recent months, we found ourselves in almost total darkness. We decided therefore, that new quarters should be arranged for.

The matter was put to a vote of the members and the shop of Harvey Morris, which he kindly offered to us, was the unanimous choice. All members please take notice that henceforth meetings will be held at Harvey Morris' shop, 6216 Charles Street, in Philadelphia. It may be reached by trolley, taking the Frankford Elevated line to the end of the line, which is Bridge Street. Then transfer to Route 66 trolley and get off at Devereaux St., 6200 N., the fourth stop above Bridge Street. Walk east (at right angles to Frankford Ave.) two blocks and turn left into Charles Street. For those who do not find the Frankford Elevated convenient and who wish to use automobiles, the following directions will help. Follow Roosevelt Blvd. to Levick Street, take road to Tacony-Palmyra Bridge, turn into this road and cross Frankford Avenue (double trolley tracks) to Charles Street. One block east of Frankford Avenue turn right on Charles Street. Remember the address—6216 Charles Street.

L. L. Menne of Washington attended a recent meeting principally for the purpose of inducting Charles J. Fehn into the office of National Vice President. Following this, we held our regular meeting which for the most part consisted of actual radio servicing under the direction of Harvey Morris. We got three radio receivers off the sick list that night and had them ready for the members to take back to their customers. After the meeting the officers went to a photographer to have a picture made, after which we stopped in for some refreshments and entertainment. We had a fine time.

Our meetings are held on the first Thursday of each month. For the present we are holding only one meeting a month. Any N.R.I. men in Philadelphia or Camden who would like to see a first class laboratory are invited to meet with us at the shop of Harvey Morris. Follow the directions above.

James Sunday, *Acting Secretary.*

———*n r i*———

Detroit Chapter

In line with our policy to meet at the homes of our members, Mr. Paterson of 18927 Westmoreland was our host at one of these sessions. Mr. Paterson gave a very interesting explanation of A.F.C. with the aid of a good blackboard diagram drawn by himself. Upon completion of his talk there was a general discussion which was very enlightening and in which members took part. Another meeting was held at the home of Robert Briggs who explained some of the workings of his transmitter. The usual open forum was held.

We have arranged for the members to take one of the government sponsored courses in Radio Receiver and Transmitter upkeep. This course covers fundamentals and advanced information including Frequency Modulation. The class meets twice a week at Lawrence Tech. One night is given to classroom instruction and the other night is spent in the laboratory.

Information regarding our meetings may be had by getting in touch with Secretary F. Earl Oliver, 3909 Bedford, or by addressing the undersigned at 5910 Grayton.

Harry Stephens, *Assistant Secretary.*

(Since last report meetings of Detroit Chapter have been held at the homes of members other than those mentioned but something happened to the report. It did not reach headquarters before this issue went to press.)

———*n r i*———

New York Chapter

Roster of new officers for the current year is now complete. They are as follows:

Chairman—Bert Wappler
Vice-Chairman—Archie D. Burt
Secy.-Treas.—Louis J. Kunert
Ass't. Sec'y.-Treas.—Frank Zimmer

Our new Chairman Bert Wappler is a fine fellow and is doing a splendid job. He has picked up where Ralph Baer left off. Ralph has joined the Armed Forces and left with the very best wishes of all of us.

The members voted on the question of whether our meetings should be cut to one a month instead of the usual two. We are glad to report that the members voted to continue the two meetings a month program. That speaks well for the type of meetings we are holding.

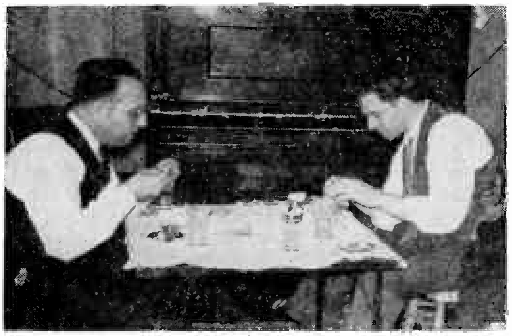
We lost a lot of our members to the various services but in spite of this we are carrying on very satisfactorily. We are also taking in some new members which helps our attendance. In our regular meeting place we had facilities for taking care of more than one hundred members and there were times when it was necessary to bring in extra chairs to take care of the overflow. However, we have no need for all this space under war conditions and we therefore have taken somewhat smaller quarters but in the same building. Please continue to meet with us at Damanzek's Manor, 12 St. Mark's Place, between Second and Third Aves., New York City.

L. J. Kunert, *Secretary.*

Chicago Chapter

Most of our meetings are held at Kaplans Hall. 3900 West 26th Street, on the south side. Attendance at these meetings is good. However, to equalize things Chairman Andresen arranges to hold an occasional meeting on the north side for the benefit of those of our members who find it too difficult to travel from one end of the city to the other. This is in line with Chairman Andresen's policy to do everything possible for the benefit of all of our members.

At one of our recent meetings we deviated somewhat from our usual routine. The Chairman asked questions on radio and asked for answers from anyone in the group. All who had anything to say on the subject were permitted to do so. This led to a very interesting discussion and the members agreed that we should have more of this in the future.



Shh! Don't let them know we are watching! Cecil Morehead and Clarence Schultz are concentrating on a snack after one of the Chicago Chapter meetings.

At one of our meetings we repaired six radios, all in one evening. They all presented difficult problems. The work was very interesting to those who are leaders in the demonstrations and who understand the work and to those who are learning and had questions to ask.

If you are interested in attending meetings get in touch with Chairman Harry Andresen at 3317 N. Albany Avenue. Telephone, Juniper 2857.

CLARK ADAMSON, *Secretary.*

—n r i—

Baltimore Chapter

"Let's go all out for our Spring opening" read a notice sent to all members of the Baltimore Chapter by Mr. L. J. Arthur, our editor. This is exactly what our members are doing.

Unlike some other Chapters which have found it advisable to hold meetings only once a month, we are still going strong with our two meetings on the second and fourth Tuesday of each month. As long as our members show such an interest in our activities, we plan to continue the two meetings a month program even through the summer months.

We are fortunate to have our meeting hall located near several street car lines, thus offering our members transportation to reach meetings without relying upon automobiles. This is one reason why our attendance is holding up so well.

Vice Chairman Rathbun continues to lead our practical servicing sessions. This means that we do real service work on balky sets which our members bring in. The newer members learn much from the older heads.

Chairman E. W. Gosnell is another reason why our attendance has been so good. He has been a tireless worker in the Chapter and always has a fine program to offer at every meeting. He does things in a business-like way and he gets the preliminaries over with without permitting them to drag and then we get right down to business.

Students and graduates of N.R.I. who live in the Baltimore area are cordially invited to attend our meetings as guests. Any who wish to join the Chapter may do so. Remember the dates—every second and fourth Tuesday—and the place: Red Men's Hall, 745 W. Baltimore Street.

P. E. MARSH, *Secretary.*

—n r i—

The True Fraternal Spirit

"I have received the Feb.-Mar. issue of the NATIONAL RADIO NEWS, and with pleasure have noted the results of the N.R.I. Alumni election of officers. Since my name was on the list of candidates for the office of Vice President, I want to take this means of sincerely congratulating every one of the winning candidates, and to express my satisfaction and pleasure with the results of the election. I would like very much to meet and know each one of these men personally.

"I also want to thank all the members of our association, who thru their votes placed my name on the ballot, for I consider it a rare honor indeed to have had my name on the list.

I'll expect to continue to receive your fine N. R. NEWS, which is a grand little magazine, and a splendid means of keeping in touch with the activities of our Alumni and School."

OLIVER B. HILL, *Burbank, Calif.*

From North Africa

I get the NATIONAL RADIO NEWS regularly and I find it quite interesting. I also get a lot of helpful dope. I am in N. Africa, feeling fine and everything is going swell. I am in the radio communications section. My N.R.I. training has helped me a lot.

ANDREW BALOG, *U. S. Army.*

—n r i—

Wealth of Information

I just had to take this opportunity to express my sincere thanks for the NATIONAL RADIO NEWS.

That little booklet contains a wealth of information. I am a subscriber to four other monthly magazines but I must admit that NATIONAL RADIO NEWS tops them all. You can quote me.

A. ATTANASIO, *New York, N. Y.*

—n r i—

With the Pacific Fleet

I want to express my gratitude for sending me NATIONAL RADIO NEWS. No matter the distance or place, it makes me look forward to the next issue. I enjoy reading about my fellow students and graduates.

JOHN FRANK PIETRZAK, *U. S. Navy.*

—n r i—

Mr. Straughn, Please Notice

In your Feb.-Mar. NATIONAL RADIO NEWS, Mr. E. Smith of Canada wanted to know what became of the Service Forum, so I am asking the same question. Would like to see it back in print. I have every book sent to me since November, 1930 and there always has been a lot of good information in the books. Keep it up.

H. E. ARMBRUSTER, *E. Portchester, Conn.*

Realizes Truth of N. R. I. Advertising

I am now a soldier of the U. S. Army. Because of my N.R.I. Training, I have been placed where I can use the theory you have taught me. I realize now the truth of your advertising. I say now, thank you for the training you have given me.

HENRY NARCISO, *U. S. Army.*

—n r i—

From a Graduate's Wife

In many of his letters (from England and North Africa) Henry has stressed the great help he has received from having taken the N.R.I. Course. He is in the Signal Corps, attached to a Bombardment Squadron of B-17's, and he is truly "keeping 'em flying."

MRS. HENRY THOMAS, *New Orleans, La.*

—n r i—

Promoted To Sergeant

Last month I was promoted to Sergeant. It's promotions like these that keep a fellow "on the ball." Over here, where news from home is scarce, the NATIONAL RADIO NEWS is certainly good reading. I share my copy with several other Radio men.

I've met a number of N.R.I. "Grads" and we have had some long chats about our training and the jobs we had back in the good old days.

SGT. ORRIS E. STARK, *U. S. Army.*

—n r i—

Signal Corps Technician

I am now a Radio Technician with the Signal Corps. The training N.R.I. gave me has been of tremendous value to me. I did not have to go to any Army Radio school. Instead, I started right into Radar school.

CPL. TECH. D. E. WALLACE, *U. S. Army.*

Sprague Announces Free Advertising Service For Radio Men

A unique, free classified advertising service announced by Sales Manager Harry Kalker of the Sprague Products Company, North Adams, Mass. is devoted to helping radio servicemen and dealers find the tubes, parts, or equipment they need during the shortages of these wartime days.

Known as the Sprague Trading Post, this Sprague effort takes the form of full page advertising appearing in leading national radio periodicals and made up almost entirely of classified "Swap or Sell" advertisements from servicemen and dealers themselves. There is no charge to servicemen for this service.

"Our sole aim", says Mr. Kalker. "is to devote our regular advertising budget to doing what we are convinced is a highly important and essential wartime job. We want to use it to cooperate with our friends throughout the radio profession in helping them get the things they need, and to dispose of the things they do not need."

Servicemen or dealers who wish to have free classified advertisements in the Sprague Trading Post are requested to send them in promptly, keeping them down to 50 words or less. Ads may be sent in, either on the serviceman's business letterhead, or on regular forms that may be obtained from their local Sprague distributors.

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Our Cover

For the month of July, NATIONAL RADIO NEWS joins all magazines of the U. S. in devoting its cover to the American Flag. Long may it wave!!!

NATIONAL RADIO NEWS

FROM N.R.I. TRAINING HEADQUARTERS

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L. L. MENNE, EDITOR
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