No. 19 How To Find the Defective
Part with an Ohmmeter

RADIO SERVICING METHODS
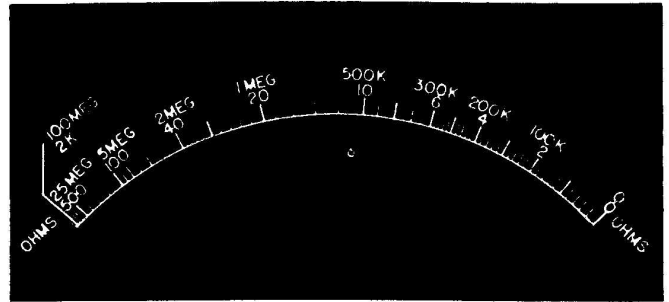
How To Find the Defective Part with an OHMMETER

AS you know, the ohmmeter and the voltmeter are tools that all servicemen use. In earlier RSM Booklets, you learned something of their uses in testing individual parts. Now you are ready to learn how to use these meters to test complete circuits for the purpose of locating defects. Such circuit testing is one very important phase of the professional servicing technique.

Voltmeter testing will be taken up in a later RSM Booklet; in this one, we shall deal entirely with the ohmmeter. Read these Booklets carefully. If you do not yet have a multimeter, be sure to come back to these Booklets and use them as the basis for practice just as soon as you do have the necessary test equipment.

CONTINUITY TESTING

In earlier RSM Booklets, we have described the ohmmeter as a device for testing individual radio parts. However, it is entirely logical to use the ohmmeter to test a group of parts—that is, a circuit—all at the same time. Then, if the circuit shows continuity and has the proper resistance, you know that the individual parts in the circuit must be all right and need not be tested. Obviously, such a procedure can save a great deal of time.

An added advantage of testing whole circuits at once is that you need not bother tracing or locating individual

parts in the circuit (unless, of course, your test shows the circuit to be defective). Practically all circuits begin and end at easily recognizable points—tube terminals or power supply terminals, for example. To check the whole circuit, you need only to connect your meter to the two end points of the circuit. This, of course, lets you work much faster than you could if you had to trace out the whole circuit before testing it. The name "reference points" is given by servicemen to the circuit "landmarks" that permit such rapid circuit testing. You will learn more about them as we proceed.

When To Use an Ohmmeter. Obviously there are some radio complaints for which ohmmeter tests are not practical. For example, any condition that shows up only when the parts are heated by the passage of relatively heavy currents may not be present when you make ohmmeter tests. Thus, cathode-to-heater leakage in a tube may never be found with an ohmmeter. Sometimes, too, by-pass condensers will break down only when they are subjected to full operating voltages. Since the ohmmeter battery is low in voltage, such condensers may test all right when you check them with an ohmmeter. Finally, there are circuits in which an ohmmeter test is reliable only when you have disconnected some part or section to prevent false readings caused by other parts in parallel. In such circuits, ohmmeter tests are possible, but often inconvenient. We have already discussed some of these possibilities when we described the testing of individual parts.

However, a great many radio troubles involve an open circuit or a short circuit. These are found readily by continuity tests.

Ohmmeters. As you have learned, an ohmmeter consists of a meter, a source of voltage, and a variable resistance. These parts are arranged so that the voltage source (usually a battery) forces a current through the meter. The circuit resistance, introduced through the test probes, changes the amount of current flow. The meter scale is calibrated to read resistance values directly.

Remember, there are two general types of ohm-

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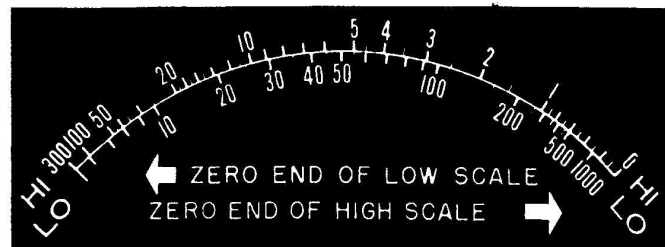
A combination scale like this is found on ohmmeters that use both series (high-ohm ranges) and shunt (low-ohm ranges) connections. Always be sure you read the proper scale.

meters. The series type reads full-scale when the ohmmeter probes are touched together; thus, zero ohms is at the *right* of the scale. The shunt type reads full-scale when there is infinite resistance between the probes; zero ohms is, therefore, at the *left* of the scale. Since both types of ohmmeter circuits are often included in the same multimeter, always be sure you know how to read the meter scale for the particular range that you intend to use.

HOW TO MAKE CIRCUIT CONTINUITY TESTS

Circuit continuity testing is basically very simple. There are two general rules that are true in every case, with the exceptions noted:

Rule 1. The plate or screen grid of any amplifier tube must show continuity (a d.c. path) back to the most positive point in the circuit, the B+ terminal. Notice that we said *amplifier* tube. The statement does not hold true for rectifiers, diodes, and triodes used as diodes (that is, those with the plate connected to the grid or cathode).

Rule 2. Any cathode, control grid, or suppressor grid must show continuity back to the most negative point in the circuit, the B— terminal. There is one exception to this—the cathode of a rectifier tube is connected to B+ instead of to B—.

▶ To make continuity tests of the circuits in a receiver, apply these rules. For example, you can check the plate circuit of an amplifier tube for continuity simply by

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touching one probe of your ohmmeter to the plate terminal of the tube socket, and the other probe to B+. (CAUTION: To prevent damage to the ohmmeter, you must always turn OFF the receiver during continuity tests.) If the ohmmeter gives any reading other than "infinite resistance," you know that there is continuity in the circuit. Remember, you don't have to *read* the meter—just notice whether the needle moves. Since many tube circuits have fairly high resistance, you should always use one of the high-resistance ranges of your meter; you use the low range principally to check low-resistance parts, such as coils.

Similarly, make a continuity check of a control grid circuit by touching one probe to B—, and the other probe to the control grid terminal of the tube socket. An ohmmeter deflection indicates continuity.

Notice that this checking involves the use of what we earlier called "reference points"—the tube electrodes and B+ and B—, in this instance. Naturally, you have to be able to locate these reference points before you can make the tests. The tube electrodes are easy to find. You can readily identify the desired terminal for any tube by referring to the base layout for that tube in a tube manual.

Finding the power supply reference points (B+ and B—) is usually just as easy if you have a schematic diagram of the receiver. That is one reason why schematic diagrams are so helpful in servicing. However, it is generally possible to locate B+ and B—, or equivalent points, even if you do not have a diagram. To show you how this is done, we will now describe how to find continuity reference points in various kinds of receivers, assuming that you have no diagram.

A.C. Receiver Reference Points. Fig. *1* shows the power supply circuit most widely used in a.c. receivers. Here, B— is the center tap of the high voltage winding. This terminal is not easy to find, but notice that it connects directly to the chassis. Therefore, all control grids, cathodes (except the rectifier), and suppressor grids must show continuity to the chassis. For example, the control grid of tube VT_1 shows continuity to the chassis

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through resistor R_1, and the cathode connects to the chassis through resistor R_2.

The most positive point in this circuit (B+) is the *cathode of the rectifier tube.* You can easily find the cathode socket terminal with the aid of a tube chart. The positive terminal of condenser C_1 is usually easy to find, and, since it connects to the rectifier cathode, it can also be used as a reference point. Both the plate and the screen of VT_1 should show continuity to the rectifier cathode or to the positive terminal of condenser C_1, whichever you choose as the B+ reference point. This is also true of all other amplifier tubes in the set.

► Notice that the d.c. path between the plate and B+ is not the same as the d.c. path between the screen and B+. The plate circuit is completed through the primary of transformer T_1, whereas the screen circuit does not include this primary. Therefore, if you were to find continuity between B+ and the screen of VT_1, but not between B+ and the *plate* of VT_1, you would know that the primary of transformer T_1 was open. That is, you would know this to be true if you had a diagram of the set; without one, you would have to check to find the open through the plate circuit. This is one more illustration of how a diagram can speed up servicing.

► Fig. *2* shows another power supply circuit often found in a.c. receivers. Here the filter choke L_1 is placed in the *negative* side of the circuit.
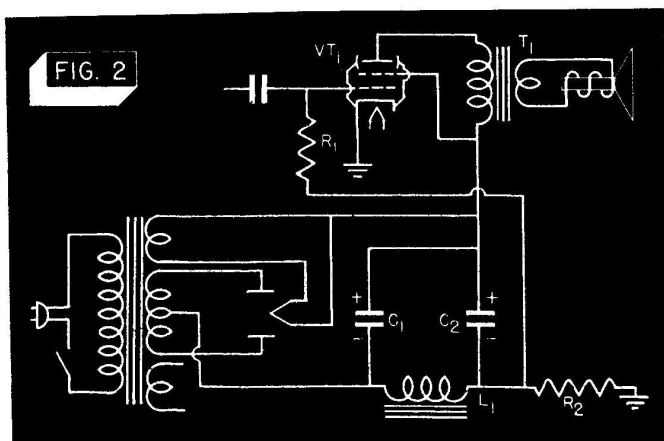

FIG. I

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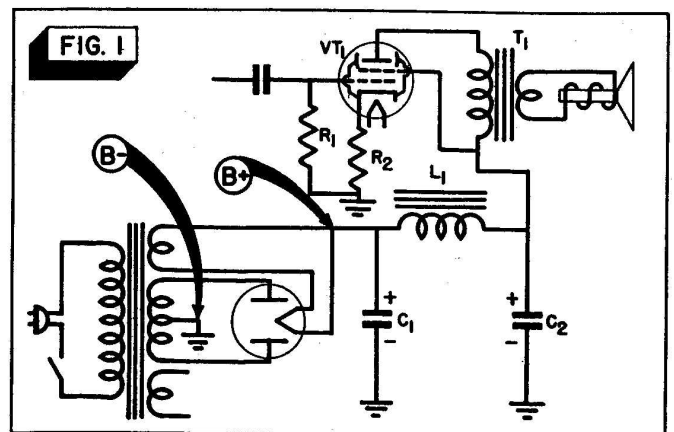
The cathode of the rectifier remains the common reference point for B+. Both positive leads of the electrolytic filter condensers connect directly to this point, as does the screen of tube VT_1. Therefore, any of these easily identified points can be used as the B+ reference point. The plate of VT_1 and the plates of all other *amplifier* tubes should show continuity back to B+; failure to obtain continuity indicates that an open exists in the circuit, just as in Fig. *1*.

The B— terminal is not connected *directly* to the chassis of the receiver in this example. However, as in every receiver using a power transformer and a rectifier tube, B— is the center tap on the high-voltage winding of the power transformer. This terminal connects to the chassis, through L_1 and R_2, but you must establish continuity between these points before you can use the chassis as the B— reference terminal. To do this, check from either of the *rectifier plate* socket terminals to the chassis. If continuity is established, the chassis may then be used as the B— reference point. The control grid should show continuity (through resistors R_1 and R_2) to the chassis. The cathode of VT_1 is already connected to the chassis, but you can check from the cathode socket terminal to the chassis to make sure that the connection has not opened up.

▶ If you do not have a diagram to guide you in selecting B+ and B— reference points in an a.c. receiver, usually you will do best to use the rectifier cathode as B+ and the chassis as B—. However, as we just said, you must make sure that the rectifier plate is connected to the chassis before you can use the chassis as B—.

A.C.-D.C. Receiver Reference Points. In the typical a.c.-d.c. receiver shown in Fig. *3*, the common reference point for B+ is the cathode of the rectifier tube. The positive terminal of the input filter condenser C_1 could be used also, but it is usually easier to locate the cathode socket terminal.

The negative leads of the electrolytic filter condensers can be used as B— reference points. Since the diagram shows that these leads go to a "ground" symbol, you might assume that the chassis can also be used as a B— reference point. However, in a.c.-d.c. receivers, ground connections are not necessarily made to the chassis; often, in fact, the chassis is not an electrical part of the circuit. The points shown as being grounded may, instead, be connected together with hook-up wire.

However, the easily located on-off switch is always in the negative side of the circuit, so it may be used as the B— reference point. Turn ON the switch (naturally, the set must be UNPLUGGED from the power outlet!), so that both switch terminals will be connected to ground. Now you can use either switch terminal as your B— reference point. If one of the switch terminals shows continuity to the chassis, then you can also use


FIG. 2

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FIG. 3

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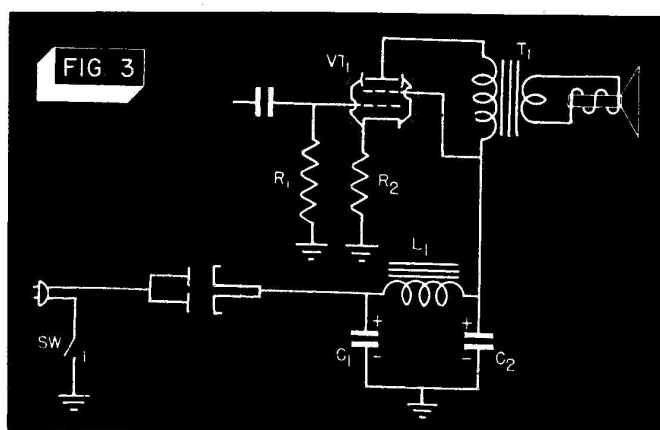
the chassis as the B— reference point.

Vibrator-Powered Receiver Reference Points. Two kinds of vibrator power supplies may be found in auto radios and in certain farm sets. One uses a rectifier tube; this type can be checked in exactly the same way as an a.c. receiver. However, the other kind, shown in Fig. *4*, does not use a rectifier tube. (This is known as a synchronous vibrator.).

In Fig. *4*, B+ is the *center tap* on the high-voltage winding of the power transformer. This is exactly *opposite* to the condition found in an a.c. receiver, where the center tap of the power transformer high-voltage winding is always B—. The center tap is not easy to locate, so a serviceman would generally use the positive terminal of filter condenser C_1 as his B+ reference. The B— terminal is the chassis.

It is best to remove the vibrator before making continuity checks, because one of the outside leads of the high-voltage winding may be grounded through a vibrator contact to the chassis. Such a connection between B+ and B— might cause puzzling test results. Many vibrators plug in like tubes and can be removed easily. However, others must be disconnected by being unsoldered. It is usually easiest to unsolder the connection to the center tap on the secondary of the power transformer in the latter case. Then, of course, the positive terminal of C_1 must be used as the B+ reference point.

FIG. 4

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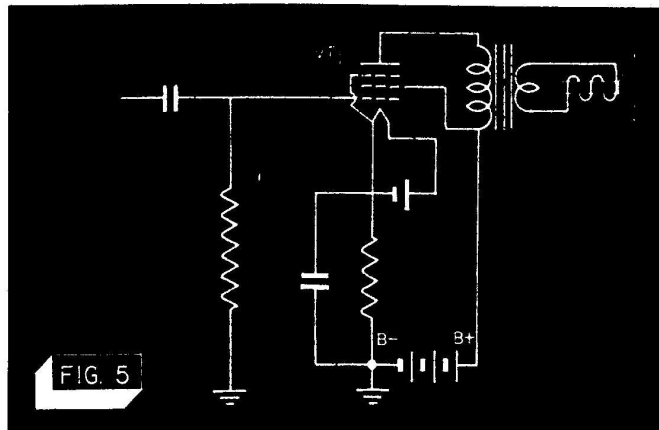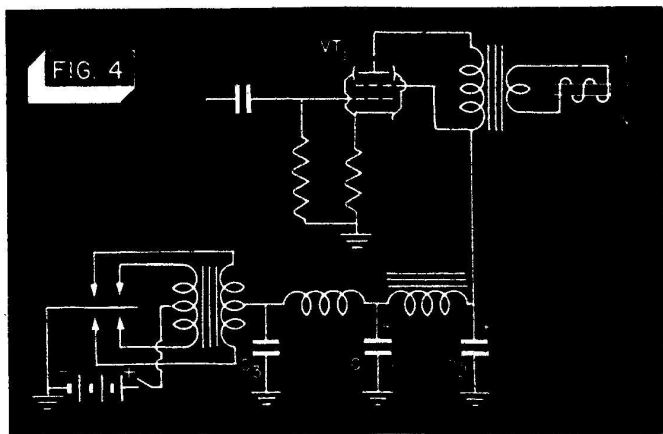
FIG. 5

Battery Receiver Reference Points. Fig. *5* shows the power output stage of a typical battery receiver. Here the B+ and B— connections are the battery cable leads. Remember to *disconnect* the batteries (not just to snap off the set) before making tests; otherwise, you may ruin your meter.
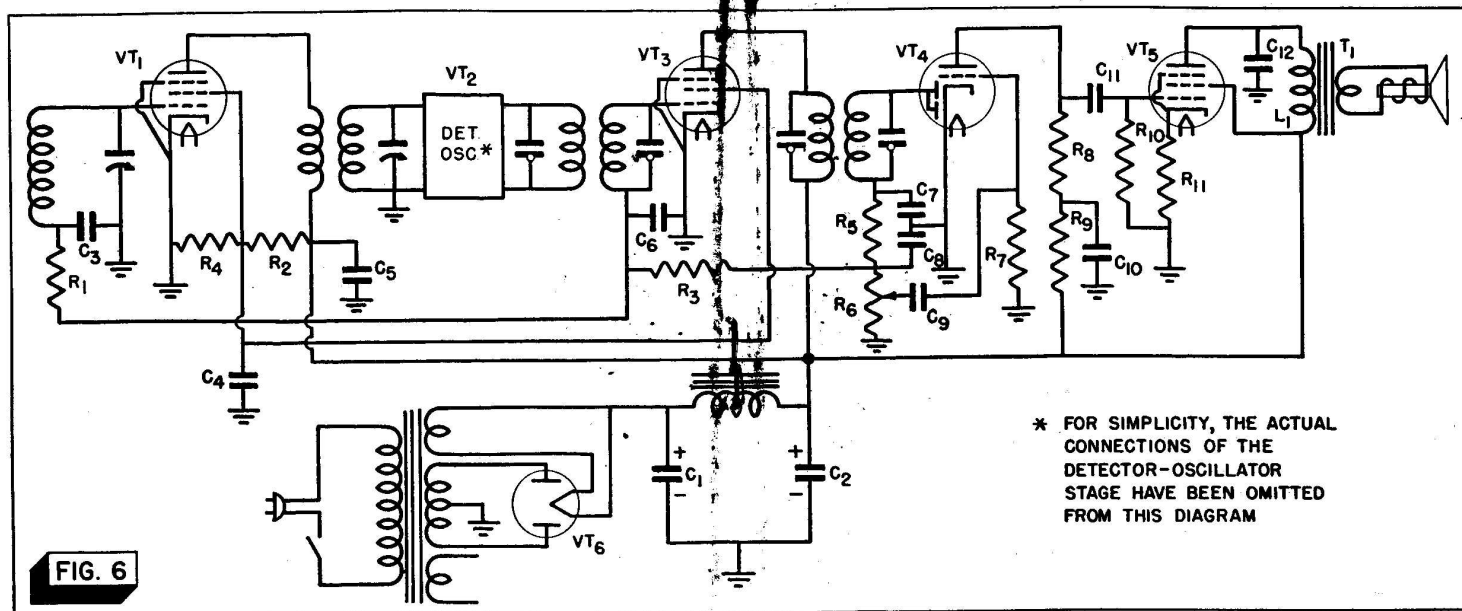
CHECKING A STAGE

To summarize what you have learned about continuity checking, let's see how you can locate an open with your ohmmeter. Let's suppose that you have a receiver with a stage in which an open exists.

First, place the chassis (with the loudspeaker connected to it) on the workbench. Turn the chassis upside down or on its side so that the parts and the tube socket of the defective stage can be easily identified and traced.

Locate both B+ and the plate prong of the tube in the defective stage. Place the ohmmeter probes on these two points.* You should get a reading. If the stage is not resistance-coupled, the reading should not be more than 10,000 ohms, but it may be as low as 1 or 2 ohms. In a resistance-coupled stage, the reading may be as much as 500,000 ohms.

▶ Suppose you do not get any reading—the meter indi-

*When using any ohmmeter or continuity tester, you must detach the power cord of the set from the line, or, if the set uses batteries, you must disconnect the cable from the batteries. THIS IS IMPORTANT.

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FIG. 6

* FOR SIMPLICITY, THE ACTUAL
CONNECTIONS OF THE
DETECTOR-OSCILLATOR
STAGE HAVE BEEN OMITTED
FROM THIS DIAGRAM

cates infinite resistance. You know then that the open is in the plate circuit. Find the wire that is connected to the plate socket terminal. The other end of this wire will be connected to the tube plate load, which may be a resistor, a transformer, or a choke. Whatever the load is, place the ohmmeter probes directly across it. If you get no reading, you have found the defective part.

If you get a reading across the plate load, follow the plate supply circuit to the next part. Check that part in the same way. If you find that it is not defective, continue checking each part until you have found the defective one.

If you prefer, you can check the parts in the plate circuit by keeping one ohmmeter probe on B+ and touching the other probe to each parts junction in the plate circuit in turn, starting from the tube. *Before* you reach the defective part, your meter will indicate infinite resistance; *after you pass it*, the meter will show continuity. You can use the same method to check other electrode circuits, working from the electrode toward the reference point.

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▶ If the plate and screen grid circuits test O.K., the next check should be for continuity between B— and the control and suppressor grids. Except in resistance-coupled circuits and a.v.c.-controlled stages, the resistance will be rather low. If continuity is not found, the individual parts must be checked.

If you have not yet found the defective part, check for continuity between B— and the cathode or filament. If an open exists in the stage, it must be in this circuit, since you have eliminated all others.

TESTS FOR SHORT CIRCUITS

An electrode circuit can show *continuity* and yet be defective if there is a short-circuit path across the circuit. Such a low (or zero) resistance path can be just as effective as an open in preventing voltage from being applied to the tube electrodes. Let's see what may happen, and how the short can be found with an ohmmeter. Fig. *6* will serve as our example.

Suppose that a short exists in screen by-pass condenser C_4. This will connect the screen grids of tubes
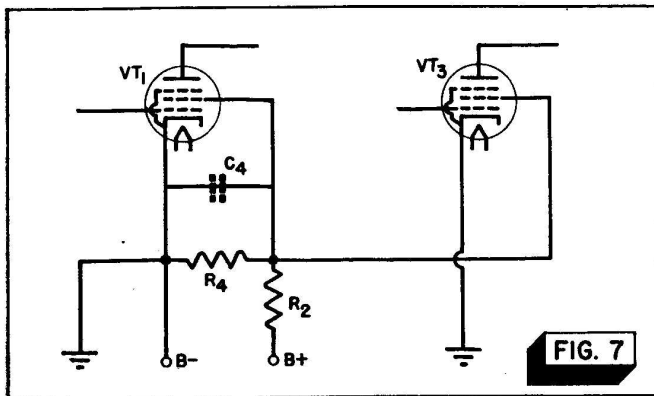
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FIG. 7

VT_1 and VT_3 to B— (or to the chassis of the receiver).

The circuit, for all practical purposes, then will be like the one shown in Fig. 7. Here the screen is connected to B— through shorted condenser C_4 (indicated by dotted lines). This connects screen resistor R_2 directly across the B supply, so the full B supply voltage will be applied across it. If the wattage rating of resistor R_2 is not high enough for the current that will flow, the resistor will burn out. If it does burn out, there will be no continuity between B+ and the screen socket terminals of VT_1 and VT_3. If the resistor does *not* burn out, there will be no voltage between the screens and B—, because, with C_4 shorted, the screens and B— are connected directly together, and no potential difference can exist between them.

You can find out if a short exists by measuring the resistance between the screen socket terminals and B—. With C_4 broken down as shown in Fig. 7, the resistance will be nearly zero, whereas the screen-to-ground resistance should equal that of bleeder resistor R_4 (usually 10,000 to 50,000 ohms).

In a case of this sort, if you find no continuity between the screen socket terminal and B+, because R_2 has burned out, *always check condenser C_4 for a short.* If you replace R_2 while C_4 is shorted, the new replacement resistor will probably burn out also.

Now suppose a short circuit occurs in C_{10} (in the plate supply circuit of VT_4 in Fig. 6). This will place R_9

directly across the B supply, as shown in Fig. 8. All of the source voltage will be dropped across R_9, and none will be applied to the plate of VT_4. Unless R_9 burns out, continuity will be found between the plate socket terminal VT_4 and B+. However, a check from the plate socket terminal to the chassis may show a resistance reading lower than normal. That is, the reading from the plate of VT_4 to the chassis will be the value of R_8, whereas the lowest expected reading should be greater than R_8 and R_9 together.

If R_8 has a high value, you may not suspect your readings unless you know the exact resistor values; this is a case in which a diagram giving parts values may save you time. (Also, a check from B+ to the chassis may show a lower-than-normal resistance reading. The reading will be equal to the value of R_9, although it should be much higher.) In any case, a check from the junction of R_9 and R_8 to the chassis will show a zero resistance if condenser C_{10} is broken down. If R_9 is burned out, it must not be replaced until an ohmmeter test of C_{10} has been made.

If C_{12} in Fig 6 is shorted, the plate of tube VT_5 is effectively connected to B—, and no voltage will be applied to the plate of the tube. The primary L_1 of output transformer T_1 will be connected across the B supply, as shown in Fig. 9, and all the supply voltage will be applied directly across L_1. This will cause L_1 to over-
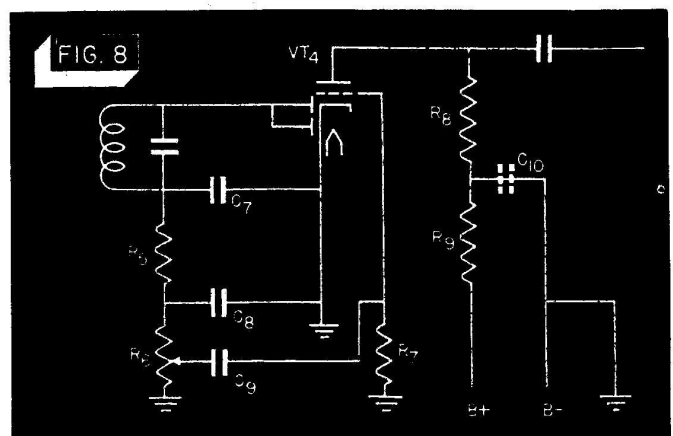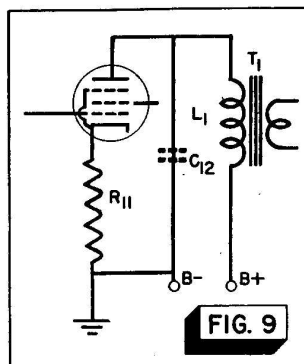

FIG. 8

FIG. 9

heat and perhaps to burn out. The plate by-pass condenser on the power output tube must be checked before an output transformer with an open primary winding is replaced.

Another short-circuit condition that is frequently found is shown in Fig. *10A*. Here, condenser C_1 and resistor R_1 form a filter. If condenser C_1 shorts, resistor R_1 will almost always burn out.

The filter R_1-C_1 is often placed inside the i.f. transformer shield can, as shown in Fig. *10B*. If continuity is not obtained from the plate socket terminal of VT_1 to B+, your ohmmeter can be used to check from the plate socket terminal to the chassis. A low resistance reading will show that C_1 is shorted.

On the other hand, if a check from the plate socket terminal of VT_1 to the chassis does not show a low resistance reading, then C_1 is not shorted. In this case, L_1 rather than R_1 is probably open, although you can be sure of this condition only if you remove the shield can
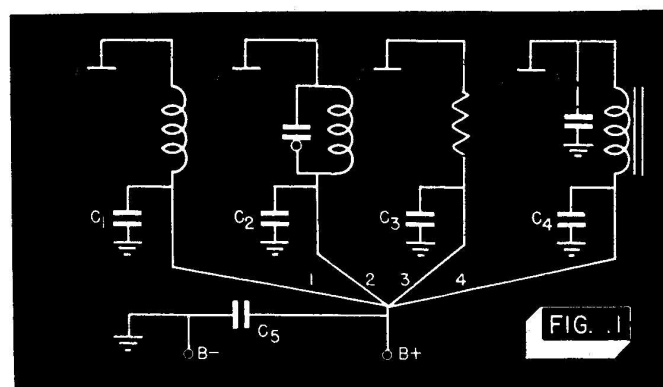

FIG. 10
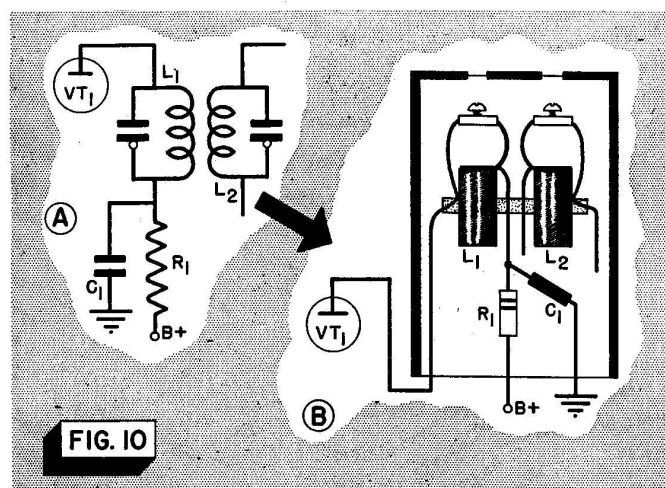
and check both L_1 and R_1 for continuity.

Remember this rule for testing for *short circuits:* The ohmmeter is *not* placed between a tube element and its *proper* reference point; instead, it is used *across* the reference points. Thus, a shorts test in a power supply is made from B+ to B—, and a shorts test for a plate or screen grid is made to B— instead of to B+. If everything is normal (*no* shorts), the shorts test will show the resistance of any bleeder used, or will show the leakage of the electrolytic condensers. Either of these readings will be far higher than a short-circuit reading.

LOCATING SHORT CIRCUITS IN PARALLEL CIRCUITS

A parallel by-pass arrangement is shown in Fig. *11*. Here you may find that a short exists between B+ and B—. (By a "short," we really mean a low resistance— even a shorted condenser usually will have some resistance, although this will seldom be as much as 100 ohms, and often will be almost zero ohms.) Any of the five condensers shown might be broken down, and the problem is to find the defective condenser.

You can do this by unsoldering leads *1, 2, 3,* and *4* at the point where they are joined to B+. Now check from B+ to B—. If you still get a short-circuit resistance reading, C_5 is probably defective, since it is still in the circuit. Disconnect this condenser and check it by itself with the ohmmeter, replacing it if it is bad.

FIG. 11

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FIG. 12

VALUES
L_1 = 25 Ω
L_2 = 50 Ω
L_3 = 600 Ω
L_4 = 3,000 Ω
R_1 = 5,000 Ω
R_2 = 10,000 Ω
R_3 = 100,000 Ω
R_4 = 50,000 Ω
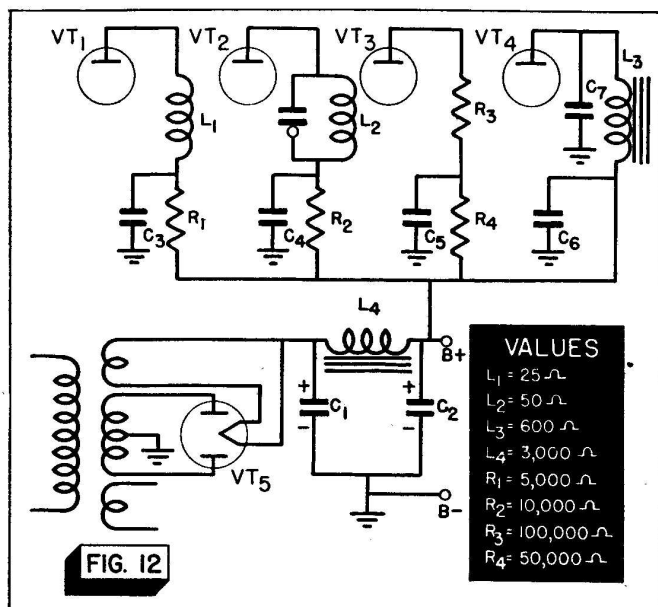
If the short between B+ and B— is not present with leads 1, 2, 3, and 4 disconnected, you know that the short to B— is in one of these leads or in a part connected to one of these leads. Therefore, check in turn between each lead and B—. The lead giving the short-circuit reading contains the defect. First, locate the condenser in the circuit that has the short, then disconnect and test it. If the condenser is defective, install another. (If the condenser is all right, faulty insulation on the lead may be allowing the bare wire to touch the chassis.)

► The B supply leads may not always come to a common point, such as in Fig. 11. Actually the circuit may appear as shown in Fig. 12. Here, you can see, there is generally a resistance between each by-pass condenser and B+. Even if one of the by-pass condensers shorts completely, you will not find a zero resistance when you check between B+ and B—; instead, you will get a reading approximately equal to the value of the resistor that is between B+ and the defective condenser. For example, if C_3 were to short, an ohmmeter check between B+ and B— would give you a reading of about 5000 ohms

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(approximately the value of R_1), for R_1 would then be connected directly between B+ and the chassis (B—) through C_3.

This fact makes it possible for you to decide which condenser is probably defective from both your ohmmeter reading and the diagram. If a check between B+ and B— in the circuit of Fig. 12 gives you a 5000-ohm reading, you should suspect that C_3 is shorted, as we just said; if the reading is about 10,000 ohms (the value of R_2), you should suspect C_4; and if the reading is 50,-000 ohms (the value of R_4), you should suspect C_5. In other words, just look at the diagram and see which plate circuit resistor has about the resistance you have measured between B+ and B—; the by-pass condenser connected between that resistor and the chassis is probably defective.

If the plate load connected between the plate and the suspected by-pass condenser has a fairly low resistance, you can confirm your suspicions by measuring the resistance between the plate and the chassis. This resistance should, of course, be very high if the by-pass condenser is not defective. If it *is* defective, however, you will get a reading about equal to the resistance of the load between the plate and the condenser. Thus, if C_3 is shorted, you will measure only about 25 ohms (the resistance of L_1) if you check between the plate of VT_1 and the chassis; if C_4 is bad, the resistance between the plate of VT_2 and the chassis will be only about 50 ohms (the value of L_2). However, it would not be much use to make a similar check between the plate of VT_3 and the chassis, because the value of R_3 is so high that your measurement would not show definitely whether or not C_5 was shorted. In this case, it would be best to locate C_5 and to test it directly. For that matter, you should always make a direct check of a suspected condenser before condemning it.

If a very low resistance between B+ and B— is measured, you cannot tell whether it is C_6, C_2, or C_7 that is shorted until you disconnect each one. (If the resistance measures about 600 ohms—the resistance of L_3—in this test, then C_7 is probably faulty. Check for this by measuring from the plate of VT_4 to the chassis. A zero or

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very low resistance reading clearly indicates that C_7 is the offender.)

INTERPRETING OHMMETER READINGS

As you have just seen, the resistance *value* is often valuable information in making shorts tests. Measuring resistance, rather than just noticing whether the meter needle moves, is sometimes a good idea also when you are making the circuit continuity tests described earlier.

Suppose, for example, you check the resistance between the cathode of the rectifier and the plate of the first tube in Fig. *12*. This circuit contains L_1, R_1, and L_4, and should have a total resistance of about 8000 ohms. If your measurement shows a resistance much higher than this—say, 15,000 ohms—you might suspect that R_1 had changed in value. On the other hand, a low measurement—5000 ohms or less—would indicate that either R_1 or L_4 was shorted. Thus, measuring the resistance will give you more information than a simple continuity check would give.

► Notice, however, that measuring the resistance will not tell you whether or not L_1 is shorted, for its resistance is so low that it could be shorted completely without affecting the total circuit resistance noticeably. In other words, as far as L_1 is concerned, an ohmmeter test of the circuit can show only whether or not continuity exists. To find out if L_1 is shorted, you must measure its resistance directly. This is always true of circuits containing high-resistance and low-resistance parts in series.
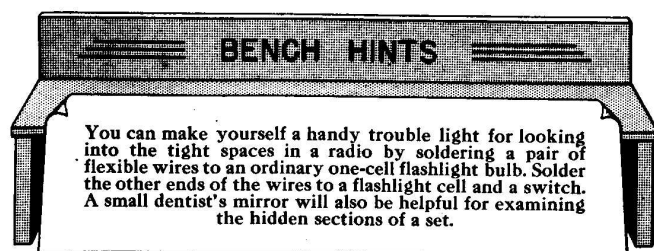
► There are certain precautions you must take to be sure that your resistance measurements show actual circuit conditions. For example, a measurement between B+ and B— in the circuit in Fig. *12* should give a reading of over 100,000 ohms, if no defects exist. This is the normal leakage value of electrolytic condensers C_1 and C_2, in parallel. These condensers, since they are electrolytics, have polarities (which are marked on the diagram). As you learned in an earlier Booklet, your resistance measurement will be accurate only if your ohmmeter is connected so that the lead that goes to the positive side of the built-in ohmmeter battery connects to

the positive side of the condenser. Therefore, if you are not absolutely sure of your ohmmeter lead polarity, you should always make *two* measurements of the resistance of electrolytics, interchanging your ohmmeter leads in between these measurements. Accept the *higher* resistance reading as the correct one.

► There is another factor that you should keep in mind. As you know, ohmmeter tests are always made with the receiver turned off. However, if you are checking between a grid and the chassis in a receiver that has only recently been disconnected from the power lines, you may find a very low resistance reading that gradually increases in value. This can happen when the ohmmeter battery makes the grid positive while the cathode of the tube is still warm enough to emit electrons; electrons flow from the cathode to the grid and through the ohmmeter. Reversing the ohmmeter test probes will make the grid negative and prevent this flow of current. If you prefer, you can wait until the cathode cools off or remove the tube from its socket.

► One final suggestion: whenever possible, use a diagram when you are making ohmmeter tests. You can work far more intelligently—and, therefore faster—when you *know* exactly what you are measuring and what you should expect to find. This is information that a schematic diagram will give you.

► Our descriptions of tests have been made with the assumption that you were working under the chassis. However, you can check the circuits (not parts) without removing the chassis from the cabinet; simply remove the tubes and insert your ohmmeter probes in the proper socket terminals. This procedure, which will enable you to discover what *circuit* is faulty, is useful if the cus-

BENCH HINTS

You can make yourself a handy trouble light for looking into the tight spaces in a radio by soldering a pair of flexible wires to an ordinary one-cell flashlight bulb. Solder the other ends of the wires to a flashlight cell and a switch. A small dentist's mirror will also be helpful for examining the hidden sections of a set.

tomer demands an estimate before the chassis is removed from the cabinet.

NRI PRACTICAL TRAINING PLAN

You will need an ohmmeter and a receiver to carry out the following practical training steps. If you do not yet have them, study the procedures carefully now, and follow them when you have secured the necessary equipment.

Step 1. Make electrode continuity tests. Make a continuity test of each electrode circuit with an ohmmeter by connecting one ohmmeter probe to a tube socket terminal and by placing the other probe on the correct power supply terminal. Referring to the circuit diagram each time, estimate what the resistance should be, then compare your estimate with the observed value. When discrepancies occur, try to figure out the reason; remember that variations of up to 20% in resistor values are often permitted in receivers, and remember that, when parts are in parallel, their combined resistance must be considered.

Step 2. Check electrode supply circuits part by part with an ohmmeter. Repeat the electrode continuity test described in Step 1, but this time, move the probe at the tube along the circuit toward the other probe, part by part, and observe the ohmmeter reading for each step. Check the reading each time against the circuit diagram.

Step 3. Check all resistors with an ohmmeter. Check the value of each resistor on the chassis with an ohmmeter, and record the measured value either on your enlarged circuit diagram (described in an earlier RSM Booklet) or on a separate chart. When a resistor cannot be checked because it is shunted by another part, unsolder one lead of the resistor, make a direct measurement, then resolder it.

Step 4. Check all coils with an ohmmeter. Check the continuity of each winding on each coil in the receiver, using the lowest range of your ohmmeter. Look through your service information for coil connection diagrams; if these are not given, use your ohmmeter to locate the terminals for each winding. Locate the terminals of power transformer windings in the same way, and

measure the resistance of each winding. Before checking the filament winding, remove all tubes. If a center-tap filament resistor is used, unsolder one lead of it temporarily. Record all readings for future reference, after comparing them with the d.c. resistance values specified on the circuit diagram.

Step 5. Check all condensers with an ohmmeter. Connect your ohmmeter across each condenser in the receiver, using the highest ohmmeter range, and note the amount of the initial flicker of the ohmmeter needle. Unsolder one lead when a condenser is shunted by some part; be sure to resolder the lead after the test. For electrolytic condensers, take one reading, then reverse the ohmmeter probe and take another reading; the higher resistance value will be a true indication of the condition of the condenser. Record both values.

Step 6. Test for short circuits. Follow the suggestions given earlier in this RSM Booklet, and make tests for short circuits by testing between B+ and B—. The exact readings you get in each instance will depend upon the kind of circuits, whether or not a bleeder resistor is used, the condition of the electrolytic condensers, and the polarity of your ohmmeter test probes. Record all readings for future reference.