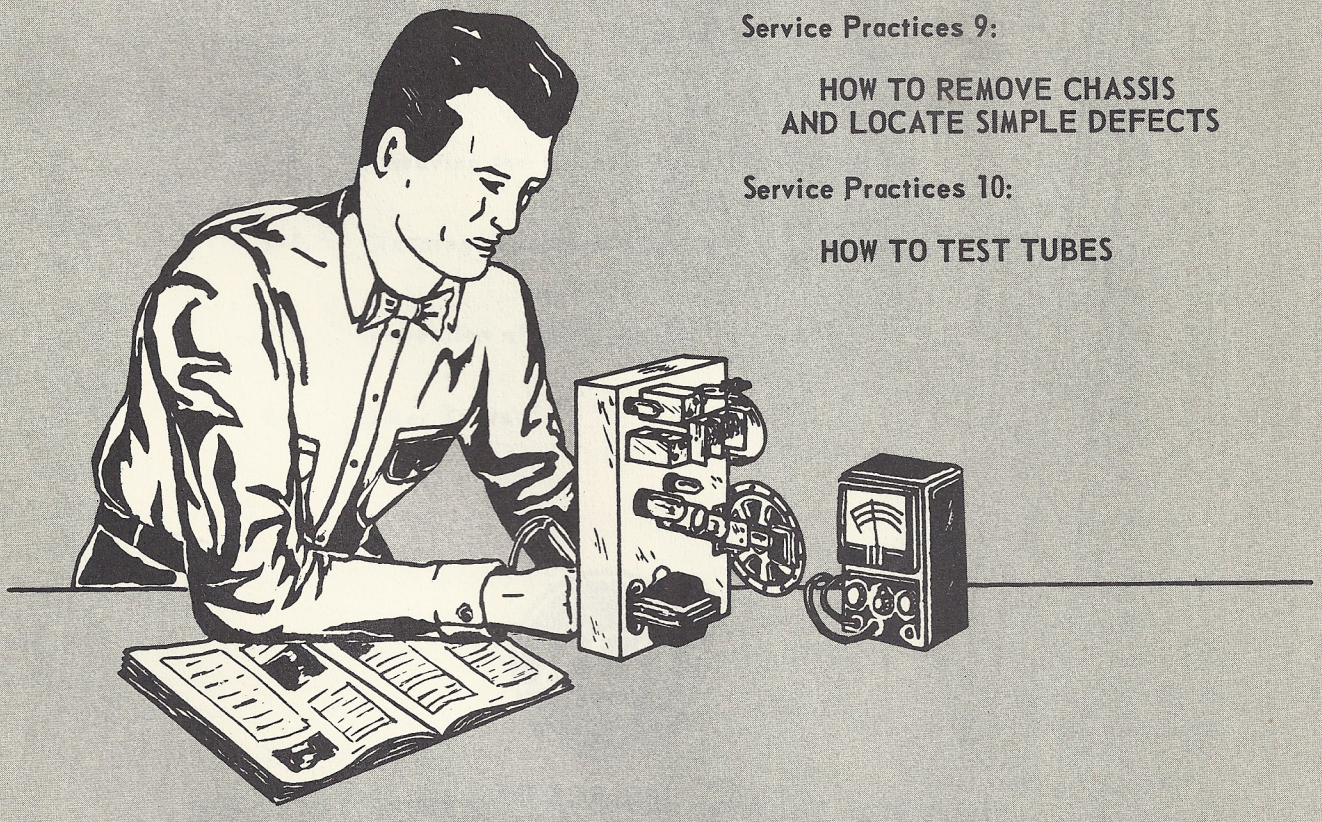
Study Group 5

ELECTRONIC FUNDAMENTALS



Service Practices 9:

HOW TO REMOVE CHASSIS AND LOCATE SIMPLE DEFECTS

Service Practices 10:

HOW TO TEST TUBES

RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

New York, N. Y.

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 9

HOW TO REMOVE CHASSIS AND LOCATE SIMPLE DEFECTS

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RCA INSTITUTES, INC.

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HOME STUDY SCHOOL

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Service Practices 9

INTRODUCTION

In order to repair almost any radio or television receiver, it is necessary to remove it from its cabinet. Almost anyone can figure out how to get a chassis out of a cabinet in one way or another, but unless you know how to do it quickly and correctly, it may take you longer to remove the chassis than to do the actual repair work. Also, unless you know what precautions to take, you may damage one or more parts of the chassis or even the cabinet itself. You will have to repair this damage at your own expense; therefore, you will lose time and money on the job. Besides that, your reputation as a radio or television serviceman will naturally suffer.

This booklet tells you how to go about removing a radio or radio-phono chassis from its cabinet. It tells you what to do, how to do it, and what special tools you may need to use. It also tells you what not to do and what to look out for, so that you won't accidentally damage the customer's property. In addition to this, it tells you about certain checks that you can make that will save you time and work. After you have had some experience, you will be able to figure out the correct way to remove even a chassis that is fastened in its cabinet in an unusual way. Because the removal of a television chassis from its cabinet requires special instructions and special precautions, it is discussed later in the course.

There is one thing that this booklet cannot do; it cannot supply you with all of the necessary knowledge of service and test methods that will prepare you to troubleshoot and overhaul a radio or phono-radio combination. However, step by step, booklet by booklet, these Service Practices booklets will give you this information. For example, the next booklet tells you how to test tubes. Later booklets tell you how to repair dial cords and tuning systems, how to test resistors, inductors, and capacitors, and many other things that you must know before you take on the job of troubleshooting and repairing radio and phono equipment all by yourself. You'll find that each Service Practices booklet is sent to you at a time when your study of electrical, radio, and television theory has prepared you to understand it better.

So, while this Service Practices booklet tells you how to remove a chassis and make some very simple tests, it does not give you the "green light" to go ahead and try to make repairs on the chassis. You will not be prepared to do such things until you have more knowledge and experience.

However, while you may not be prepared to service radio equipment all by yourself, it is possible for you to use the information you already have and to gain experience by helping some friend who does radio service work or by doing some part-time work in a local radio-television service shop. There are many things that you can do to help in a service shop, even though you are not prepared to do the testing and troubleshooting. And, of course, as you read each Service Practices booklet, you will add new ways to apply your knowledge and increase your usefulness in the shop.

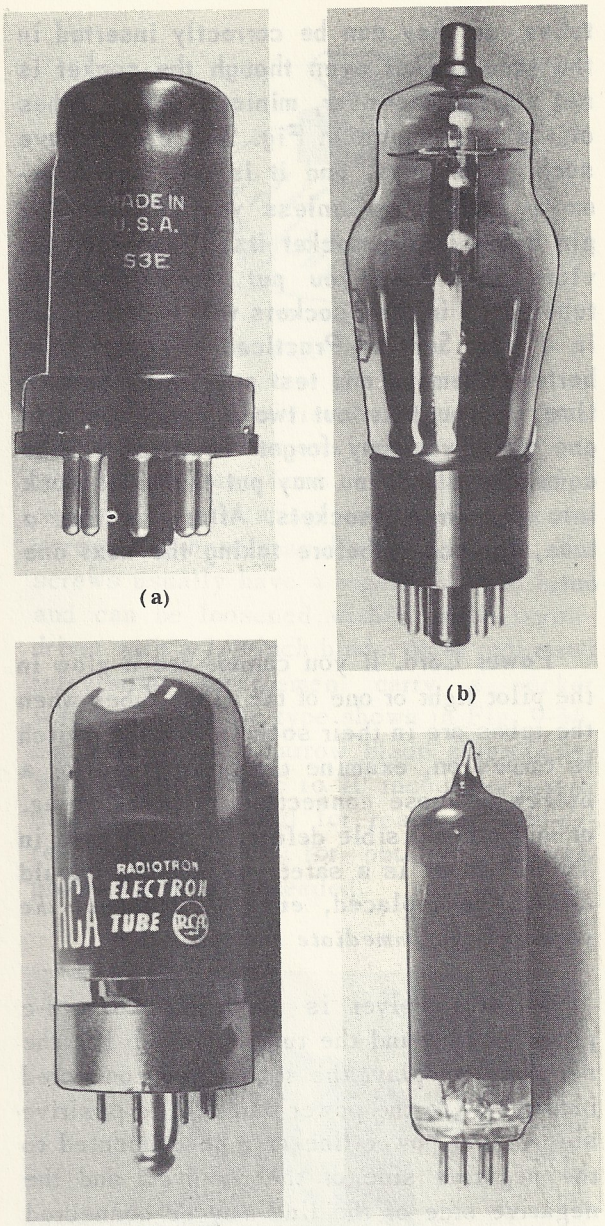
9-1. FIRST STEPS

Before you take a chassis out of its cabinet, make sure that it is really necessary to do so. Of course, if you know that the chassis must be removed or if you are help-

ing out in a service shop and are told to remove the chassis, then there is no question about it – the chassis must come out. However, if you are in a customer's home, or if the customer has brought a radio or phono-radio combination to the shop for service, you can find out if it is necessary to take the chassis from its cabinet by making some simple checks. First, turn on the receiver yourself to check the customer's complaint. In many cases, you will find that the trouble shows up right away. Sometimes, the receiver may operate properly and not seem to have anything wrong with it. In such a case, ask the customer to operate the receiver and show you the trouble. You may find that the customer does not know how to tune the receiver properly and needs to be shown how to do it correctly. Or, if the trouble does not appear when you first turn the receiver on, the trouble may be an *intermittent* one, that is, one that comes and goes. Troubles of this type may show up after the receiver has been operating for some time. If you are in the customer's home, you will have to take the receiver to your shop and let it operate on your workbench until the trouble shows up. The customer may tell you that striking the receiver causes the trouble to appear, or that when the trouble appears, jarring the receiver restores it to normal operation. Let him show you this, but do not strike the receiver or chassis yourself in the customer's presence. (Later Service Practices booklets will tell you how to test a receiver in this condition.)

If the operation of the set shows there is something wrong, make the following checks before starting to remove the chassis.

Tubes. Check the tubes. If the trouble is due to one or more defective tubes, it may be possible to correct the trouble without removing the chassis from the cabinet. Complete information on testing tubes is given in your next Service Practices booklet. However, before testing tubes, make sure that no tube is missing and that each tube is firmly seated in its socket. A missing tube will naturally cause trouble, and a loose tube may do the same.



(a) (b) (c) (d)

Fig. 9-1

Caution: Before testing tubes, examine the position of each tube to see whether it can be easily removed, tested, and returned to its socket without first removing the chassis from the cabinet. Although it is easy to pull a tube out of its socket, if you can get hold of it and there is room for the tube to clear the cabinet, it is not always easy to get the tube back into its socket again. Also, it is necessary to be able to see the socket in order to replace some tubes. Standard-size metal, glass, and lock-in type tubes, as shown in Fig. 9-1a, b, and c, have keys and guides for inserting the

tubes so they can be correctly inserted in the tube socket even though the socket is not visible. However, miniature glass tubes of the type shown in Fig. 9-1d do not have such guide keys, and it is best not to remove such tubes unless you can see the pin holes in the socket itself. (Special devices that help you put these miniature tubes back in their sockets will be described in a later Service Practices booklet.) It is better to remove and test only one tube at a time; if you take out two or more tubes at one time, you may forget where each tube comes from and you may put the tubes back into the wrong sockets. After you test a tube, replace it before taking the next one out.

Power Cord. If you cannot see a glow in the pilot light or one of the glass tubes when the tubes are in their sockets and the switch is turned on, examine the power cord for a broken or loose connection, a broken plug, or any other visible defect. A power cord in bad condition is a safety hazard and should always be replaced, *even if it is not the cause of the immediate trouble.*

If the receiver is connected to a d-c power source and the tubes light up but the set does not play, the set may be connected incorrectly to the power outlet. The positive side of the power line may be connected to the negative side of the receiver, and the negative side of the line may be connected to the positive side of the receiver. Servicemen call this *reversed polarity.* To check for reversed polarity, remove the attachment plug from the power outlet, turn it half-way around, and plug it in again. Then, if the trouble was reversed polarity, the set will operate.

Antenna. Examine the connections to the loop antenna. If the rear of the cabinet is open, this connection can be easily seen. If the cabinet has a back, it must be removed in order to examine the antenna. Make sure that the antenna connections are good and that none of the leads short against each other or against the chassis. If you are in the customer's home and an outdoor antenna is used, examine the connections both at the receiver and at the point where the antenna enters the house.

Switches. Examine all switches on the receiver and phono-radio combination. If a switch is used to change the receiver tuning from the broadcast band to the FM band or to one or more short-wave bands, turn it to the broadcast-band position. Then tune the receiver to see if it operates at any part of the dial. Sometimes there are no local broadcasts on the FM band, or the short-wave bands may be unusually quiet, so that the receiver may seem to be *inoperative* (a term that servicemen use often and which means *does not operate or does not work).* Examine the position of the radio-phono switch, if one is used. Such a switch is used to change over the receiver from radio to phonograph operation; the receiver will appear completely inoperative if this switch is in the phono position. If you are examining a radio receiver in the customer's house, you may find that there is a special line that runs from the receiver to a phono player in some other part of the room. This line may include a switch or jack that is used to silence the radio when the phonograph is operated. So, if you find cable or wires leading away from the receiver that you cannot account for, ask the set owner to tell you what they are connected to, if they are controlled by switches, and if the switch is in the radio position.

9-2. SAFETY PRECAUTIONS

When working in the customer's home, always keep in mind the following safety precautions:

1. Clear a working area around the radio receiver so that you will have room in which to work and so that there will be no danger of your knocking over lamps, vases, or other easily-broken articles that are normally nearby. It may even be necessary to move one or more pieces of furniture to one side to give you working room. However, before

moving anything, ask for the customer's permission. In many cases, you will find that the customer will prefer to move a delicate vase or lamp herself, rather than permit you to handle it. In fact, it is much better to let the customer handle any easily-broken articles, so that you do not take the chance of accidentally breaking something while moving it. If any furniture must be moved to give you room, do not attempt to move it by yourself unless it is of a reasonable size and weight. You should not move furniture that is unusually large or heavy without some assistance.

2. Never place your tools on top of the receiver or phono cabinet, on any other piece of furniture, or even on the floor. Spread a drop cloth, such as the one shown in Fig. 9-2, for your tool box or tools. This will prevent the scratching of either the furniture or the floor and make it easy for you to collect all your tools when you have finished your work.

3. If it is necessary for you to use either an extension lamp for a working light or a soldering iron, make sure that the wires are not placed where someone may trip over them. Have a good holder for your soldering iron so that it will not fall off and cause burns.

4. Make sure that the power cord is disconnected before you begin removing the chassis from the cabinet.

9-3. REMOVING THE CHASSIS FROM THE CABINET

Removing the Knobs. The first step in removing the chassis is to remove the knobs from the control shafts that come through the holes in the cabinet. This is sometimes much easier said than done. For this reason we must consider how these knobs are fastened to the shafts and why they might be difficult to remove.

A knob is held on its shaft either by a set screw or by a spring pressure. A set

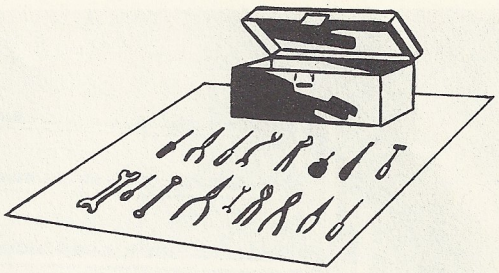
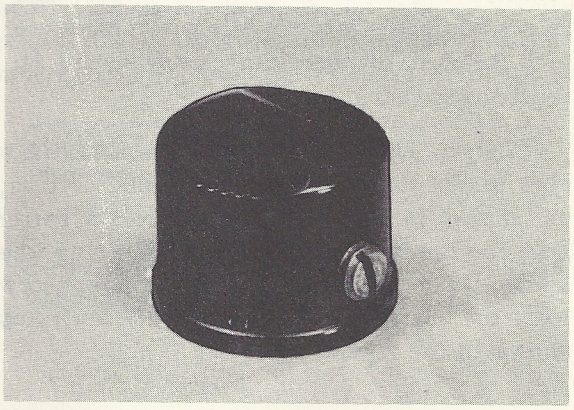


Fig. 9-2

screw type of knob is shown in Fig. 9-3*a*. One or two set screws may be used. See whether or not a knob is fastened with a set screw by rotating it. If there is a set screw, its head may be easily seen. Set screws usually have a regular slotted head and can be loosened with a small screwdriver with a 1/8-inch blade. Most radio and television servicemen carry a pocket screwdriver of the type shown in Fig. 9-3*b*, but sometimes a narrow blade screwdriver with a shaft from 6 to 10 inches in length can be very useful for reaching hard-to-reach places and for obtaining enough power where it is needed.



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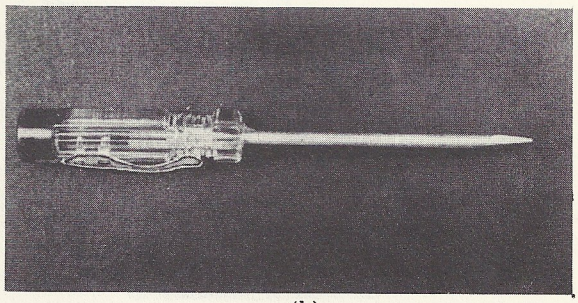


(b)

Fig. 9-3

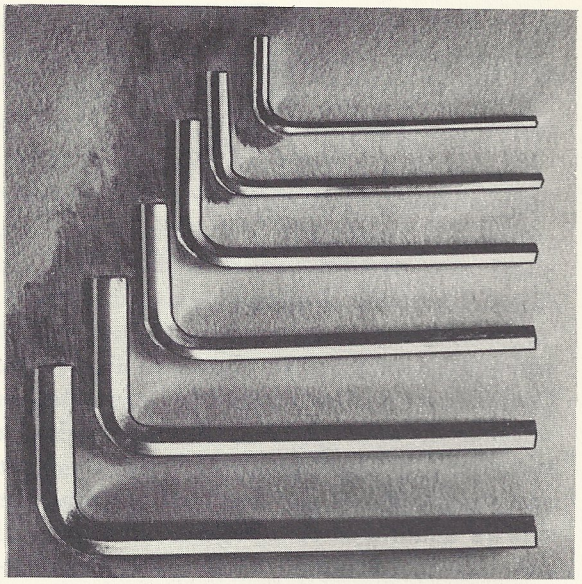


Fig. 9-4

Some knobs are fastened with Allen-type set screws. This type of screw has a six-sided socket instead of a straight slot and is fastened and unfastened by an Allen or hex-wrench. Figure 9-4 shows several Allen set screws and wrenches. Kits containing five or six wrenches of the most useful sizes for radio and television servicemen can be obtained in most radio and television parts stores. Allen wrenches are also needed for servicing many types of record changers.

Control shafts designed for set screw type knobs usually have a flattened portion, as shown in Fig. 9-5, to provide a better grip for the set screw. When replacing the knobs, take care to line up the set screw with the flattened portion of the shaft, as shown in the figure.

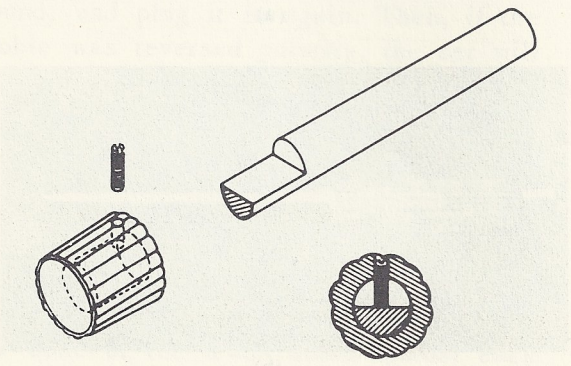


Fig. 9-5

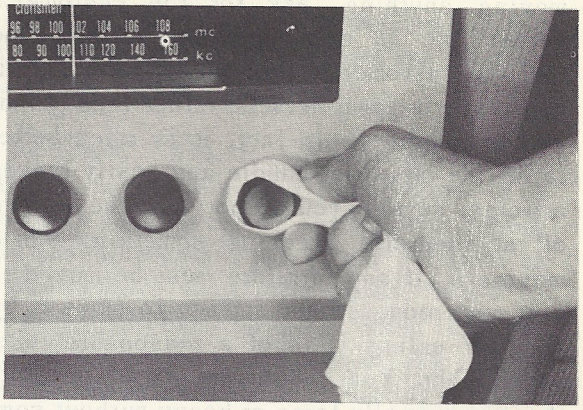


Fig. 9-6

Sometimes, due to swelling or corrosion, the knob will not come off the shaft after the set screw has been loosened. A better grip can be obtained on such stubborn knobs by wrapping a piece of strong cord, cotton tape, or even a handkerchief underneath and around the knob as shown in Fig. 9-6. You will then be able to pull harder on the knob.

However, be sure to pull straight back, without any sidewise pressure, or you may bend the shafts. Commercial knob pullers, such as the one shown in Fig. 9-7, are available, but you may scratch cabinets when you use them. A useful protective shield can be used with a knob puller. It can be made from a piece of thin cardboard about two or three inches square, which can be slipped over the shaft behind the knob, as shown in Fig. 9-8, and will protect the cabinet while the knob puller is in use.

In certain instances, it will not be possible to remove the knob. There may be so

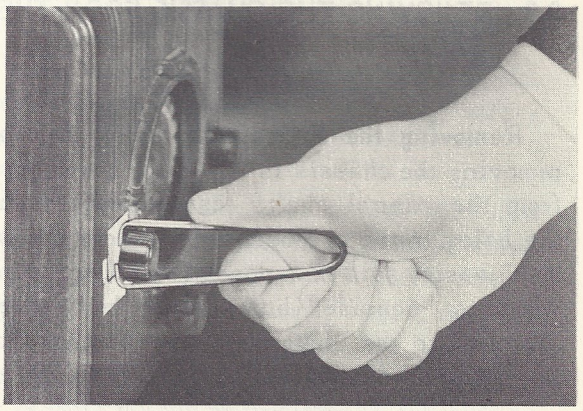


Fig. 9-7

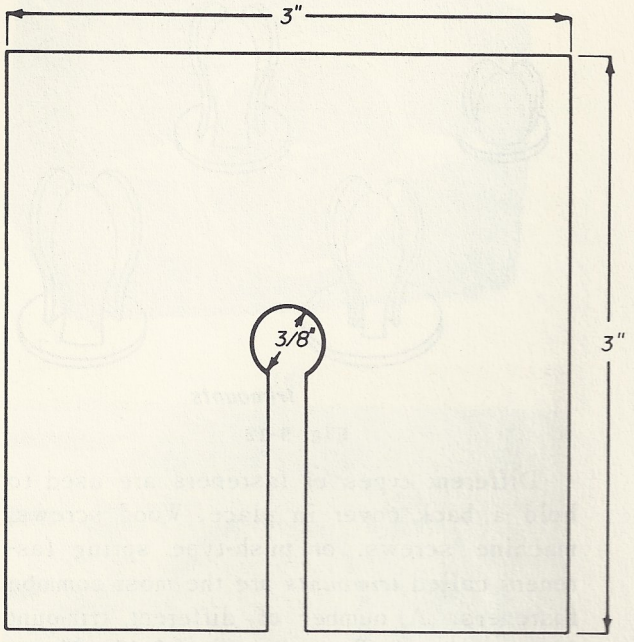


Fig. 9-8

much swelling or corrosion that it cannot be pulled off. The slot in the set screw may be broken or worn so that the set screw cannot be loosened. The only thing you can do then is to break the knob in order to remove the the chassis. When it is necessary to break the knob, and if you are working in the customer's home, explain the need for breaking the knob to the customer before you attempt to break it. In this way, she will not become alarmed and think that you are willfully destroying her property. When breaking a knob, be careful that you do not cause any damage to either the cabinet or the chassis. A good method of breaking knobs is to squeeze the knob with gas or adjustable pliers, after first protecting the cabinet with a cardboard shield like the one described above. Apply pressure with the pliers slowly until the knob breaks. The replacement knob should match the remaining knobs of the receiver. If you cannot find a matching knob, the entire set of knobs should be replaced. If it is necessary to order a set of knobs, give the customer a knob that doesn't match until the new knobs arrive. Explain this to the customer.

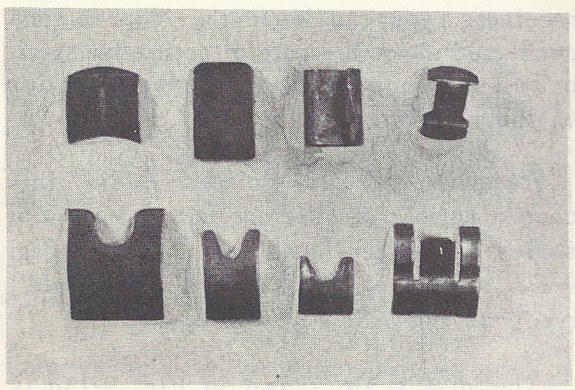


Fig. 9-9

If no set screw is visible, the knob is held on the shaft by some type of spring pressure. The springs may be inserted inside the knob so as to cause a tight fit between the knob and the shaft. Some springs of this type are shown in Fig. 9-9.

Another method of holding knobs tightly is the split shaft, shown in Fig. 9-10*a*. The part over which the knob fits is usually *knurled*, or grooved, as shown. When the knob is pushed on the knurled part of this shaft, it squeezes the split sections together lightly, creating a spring pressure. A knob held on by spring pressure can be removed by pulling it straight back off the shaft. Usually, these knobs can be easily removed with the fingers. If not, they can be removed with a knob puller. When you remove

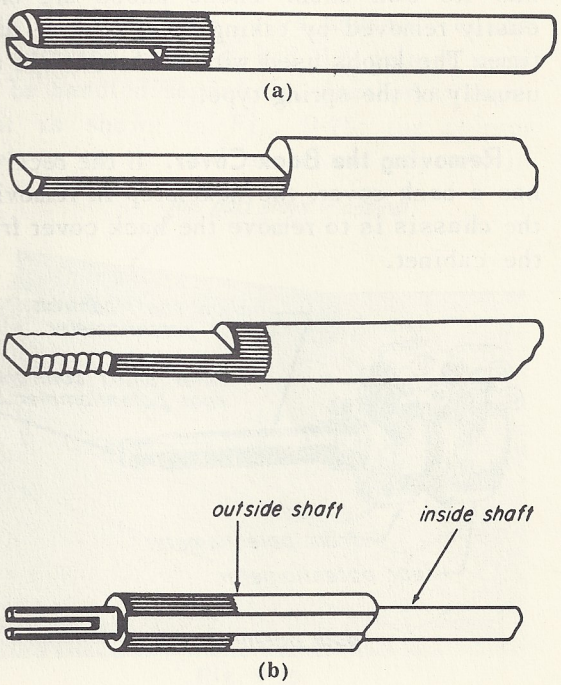


Fig. 9-10

a spring-type knob, a spring like those in Fig. 9-9, the springs may fall out. Be on the look out for this so that you do not lose them.

When replacing the spring, be careful not to put it in backwards, as this will make it very hard to remove the knob. You can find out the correct way to replace the spring by checking one of the other knobs. The top two shafts shown in Fig. 9-10*b* are used on single controls. The remaining shaft, sometimes found on dual controls, uses a split shaft for one control and a knurled shaft for the other.

Pushbutton knobs are usually of the spring type. Other pushbuttons are held by force fit, or friction, between the inside of the knob and the pushrod. The chassis may sometimes be removed without removing the push-button knobs.

Sometimes dual or concentric controls are used. Such a dual control is shown in Fig. 9-11. One of the two controls has a hollow shaft. The two controls are placed one behind the other, with the shaft of one control going through the hollow shaft of the other. Such controls reduce the apparent number of knobs on the front panel, thus improving the cabinet's appearance. Each shaft has its own knob. These knobs are most easily removed by taking them off one at a time. The knobs used with such controls are usually of the spring type.

Removing the Back Cover. If the receiver has a back cover, the next step in removing the chassis is to remove the back cover from the cabinet.

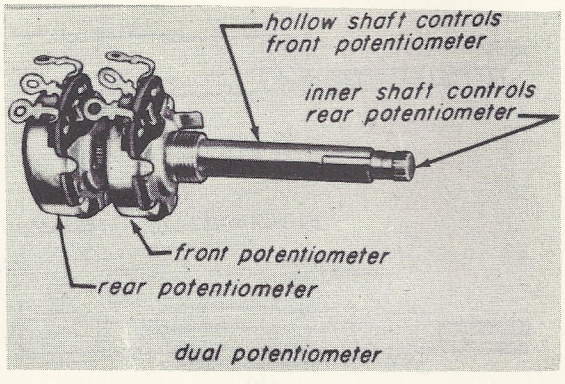


Fig. 9-11

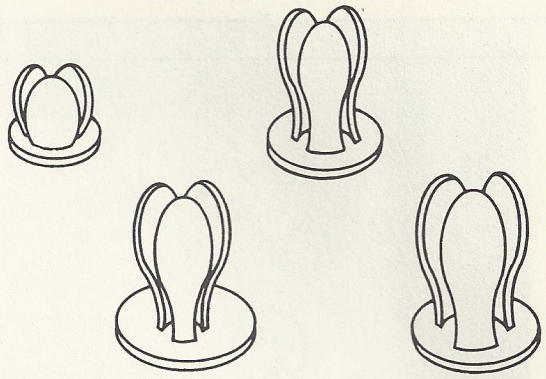


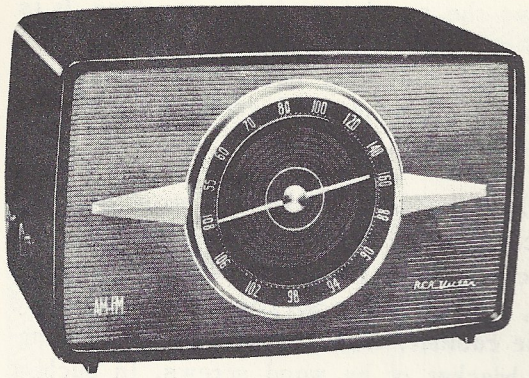
Fig. 9-12

Different types of fasteners are used to hold a back cover in place. Wood screws, machine screws, or push-type spring fasteners called *trimounts* are the most common fasteners. A number of different trimount fasteners are shown in Fig. 9-12. These fasteners hold by spring pressure against the sides of the hole into which they are inserted. They are removed by placing a screwdriver under the head of the fastener and prying it up. To reinsert the trimount fastener, push it straight back into the hole in the cabinet.

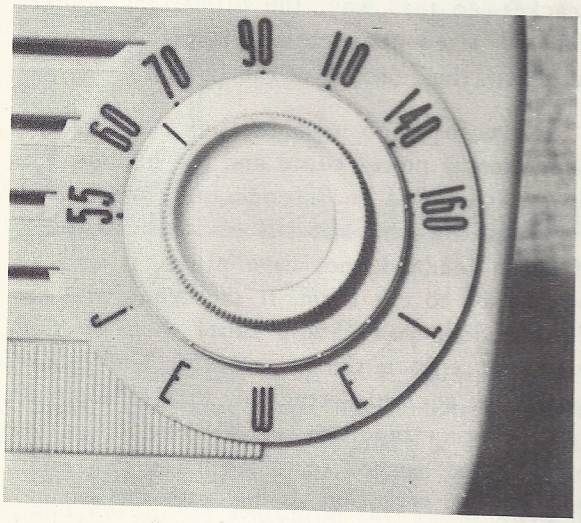
After removing the fasteners that hold the back cover in place, tilt the cover outward carefully to see if a loop antenna or any other wiring is attached to the back. See if the antenna or wiring is held by pin-type connectors or terminals that may be disconnected. If you cannot disconnect the loop antenna, you should decide whether you must unsolder the loop antenna or you can work on the chassis without damage to the loop antenna or other wiring. In most small receivers, you can leave the loop antenna connected if you are careful not to damage it or pull the connections loose while working on the receiver.

Removing the Dial Pointer. Radio dials have a number of different forms. Most dial scales are either round, as shown in Fig. 9-13*a* and *b*, or straight (the "slide-rule" type), as shown in Fig. 9-13*c*.

The dial scale shown in Fig. 9-13*a* is attached to the chassis, and both the dial



(a)



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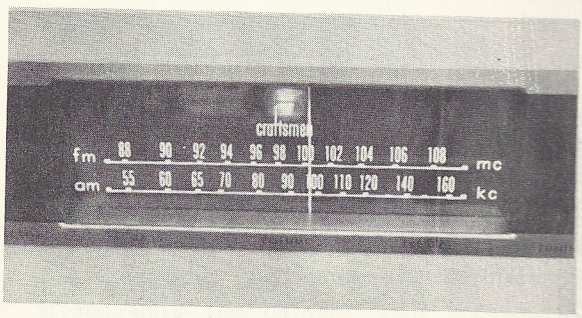


(c)

Fig. 9-13

scale and pointer are behind a glass or plastic window in the cabinet. The pointer need not be removed separately since the entire assembly comes out together with the chassis.

The dial scale shown in Fig. 9-13*b* is part of the cabinet front, and the dial pointer is outside of the cabinet (like a knob). The pointer is held on the shaft either by spring pressure or by a set screw. This pointer

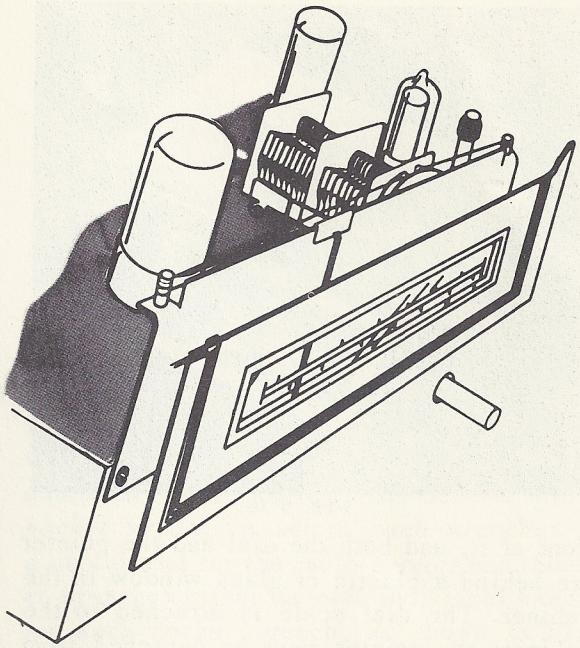


Fig. 9-14

must be removed before the chassis can be removed from the cabinet. It is removed just as a knob is, as described in the paragraphs on the removal of knobs.

The pointer for the straight-type dial scale, shown in Fig. 9-13*c*, may be attached in a number of ways. Figure 9-14 shows the pointer supported by a back plate so that it is behind the dial scale.

In this case, the entire assembly comes out with the chassis, and the pointer need not be handled separately. Another arrangement is shown in Fig. 9-15; the pointer clips on to the dial scale and appears in

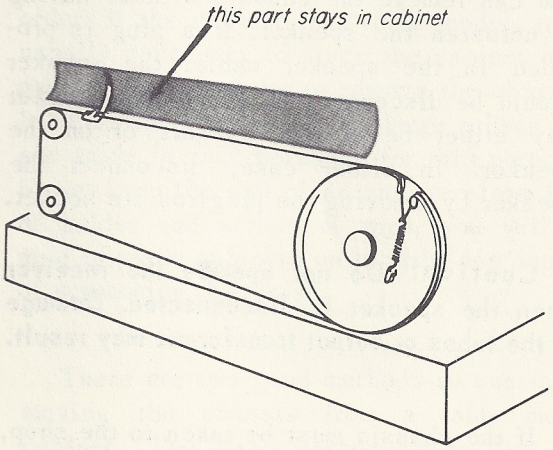


Fig. 9-15

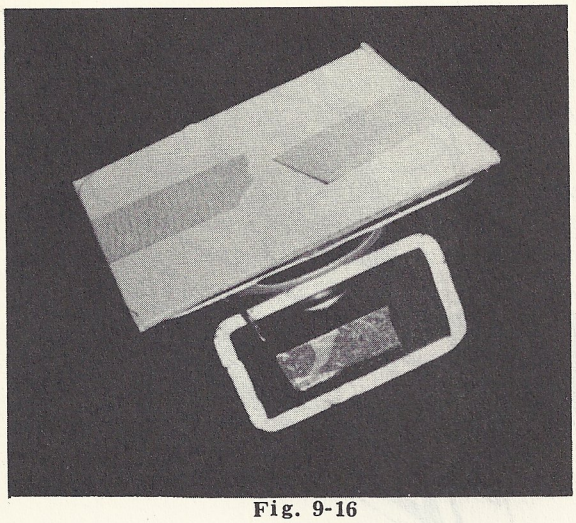


Fig. 9-16

front of it, and both the dial and the pointer are behind a plastic or glass window in the cabinet. The dial scale is attached to the cabinet; the pointer must be detached from the dial scale before the chassis is removed. If it is not, the dial pointer may be bent, the dial scale may be broken, or the dial cord may be pulled off the pulleys. To detach a pointer of this type, lift it up to release it from the dial scale and bring it over and behind the dial scale.

Dial assemblies are discussed more completely in a later Service Practices booklet.

Disconnecting Cabling. In most small sets, the speaker is attached to the chassis, and both are removed as a unit. In larger cabinets and in console models, the speaker usually is attached to the cabinet. The leads to the speaker may be long enough so that you can remove the chassis without having to unfasten the speaker. If a plug is provided in the speaker cable, the speaker should be disconnected. The plug or socket may either be on the chassis or on the speaker. In either case, disconnect the speaker by removing the plug from its socket.

Caution: Do not operate the receiver when the speaker is disconnected. Damage to the tubes or output transformer may result.

If the chassis must be taken to the shop, and you do not have a suitable test speaker, remove the speaker and take it along. It is good practice to protect the paper cone of the speaker against accidental damage by taping a piece of stiff cardboard over the cone, as shown in Fig. 9-16.

The pilot-light sockets in most sets are attached to the chassis and are removed with the chassis. In some console models, however, the pilot-light sockets may be attached to the cabinet, either by some type of spring-clip bracket or by wood screws. In such a case, unclip or unscrew the pilot light bracket. In this way, the pilot-light bracket and the wires connected to it will not interfere with the removal of the chassis.

In radio-phono combination models, the phono-motor power cable and the phono-pick-up cable should be disconnected and pulled clear of the chassis before it is removed. If these leads do not have plugs, it will be necessary to cut them. If the leads are not color-coded, you should label them so that you can replace them correctly. The labels should be securely attached, with cellophane tape or other tape, so that they will not fall off. A good method is to label the two ends of the first wire that is cut with the number 1, the next two wires with the number 2, and

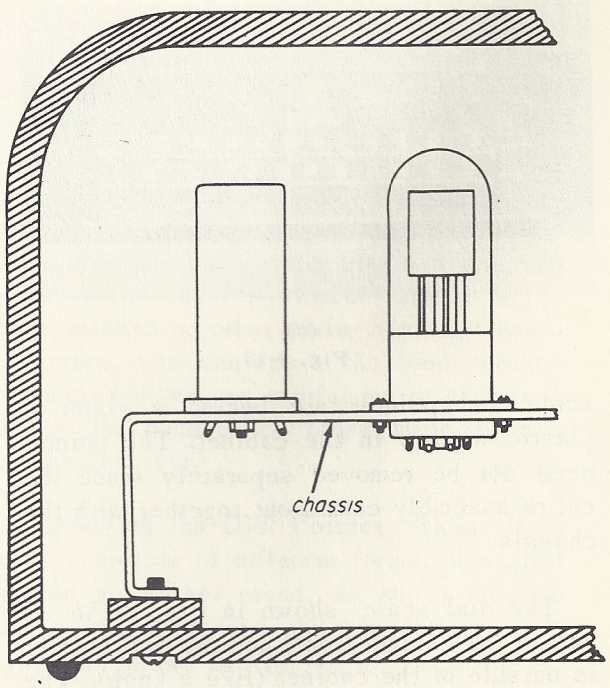


Fig. 9-17

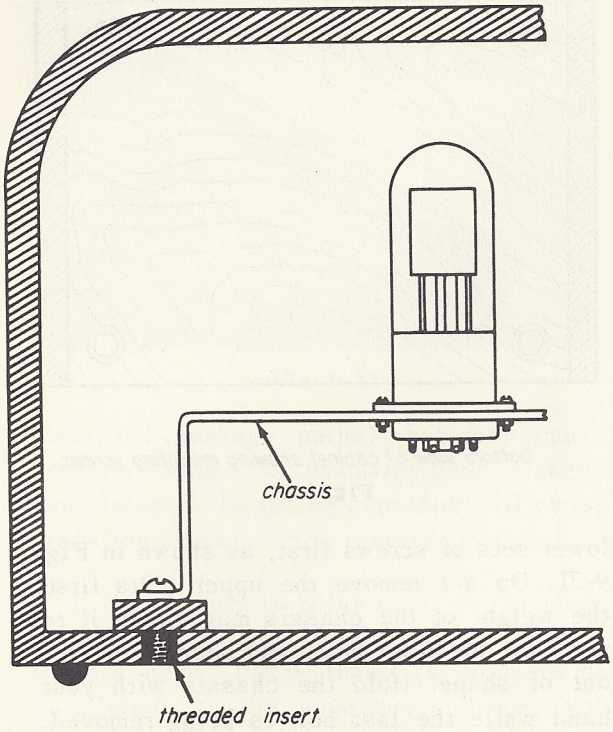


Fig. 9-18

so on. When the receiver is to be reassembled, just match up the numbers. Another convenient method is to make a single knot in each end of the first wire as it is cut, and so on. By matching the knots when the receiver is to be reassembled, you can make the correct connections. Make sure that the connections are securely soldered and carefully taped when you replace the chassis in the cabinet.

Removing the Chassis. After you have removed the knobs, the back cover, the dial pointer, and the cabling, you can remove the chassis itself. In most cases, the chassis is attached to the cabinet with screws. The screws may go through threaded holes in the cabinet into a flange on the bottom of the chassis, as shown in Fig. 9-17, or through a flange on the top of the chassis into a threaded insert in the chassis, as shown in Fig. 9-18. Sometimes the chassis is separated from the cabinet by rubber or some other shock-absorbing material, as shown in Fig. 9-19.

The screws used to hold the chassis and cabinet together may be machine screws, self-tapping (P-K) screws, or hex-head

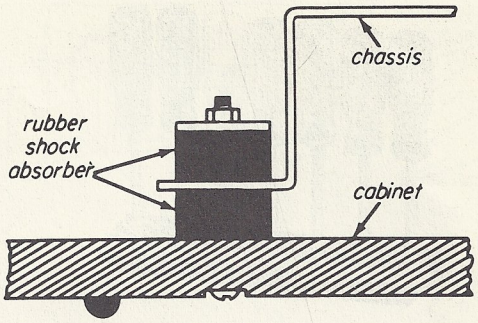
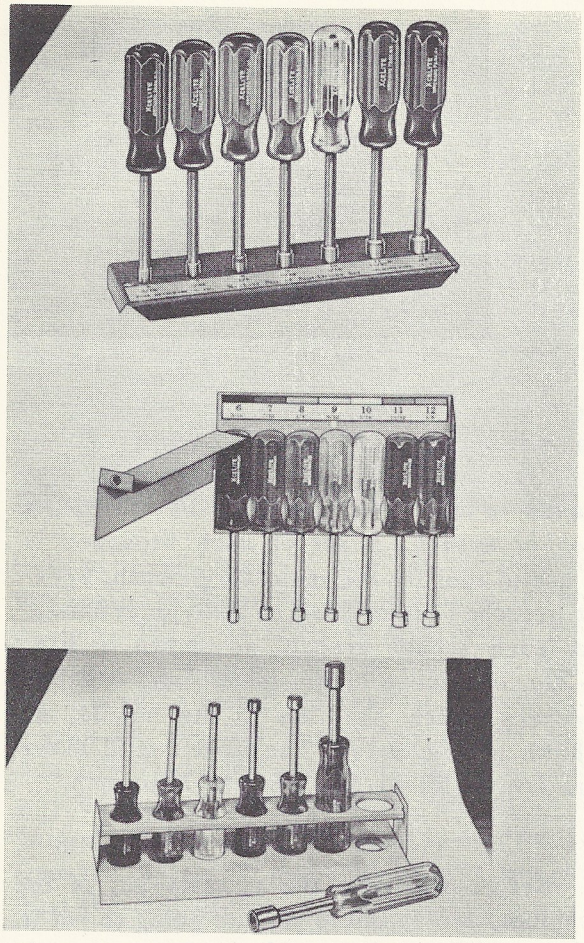


Fig. 9-19

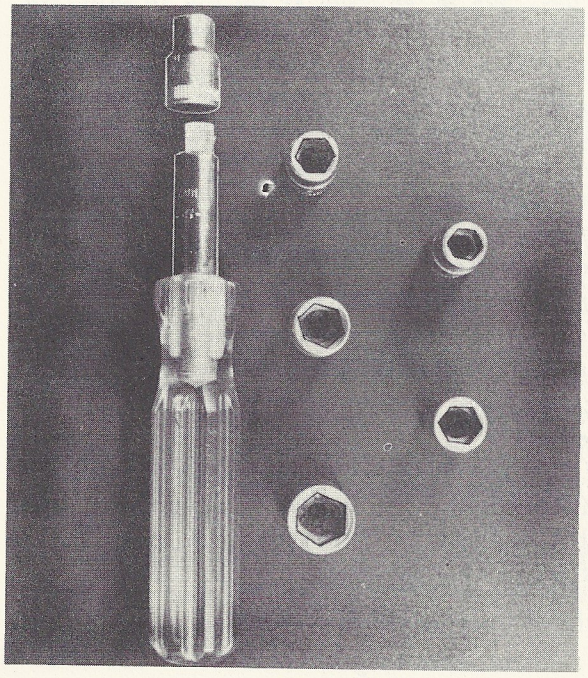
screws. A hex-head screw may have a regular screwdriver slot; if so, it can be removed with an ordinary screwdriver. However, it is easier to remove all hex-head screws with a *socket wrench*. A set of such wrenches is a useful tool for the radio serviceman. Socket wrenches either have an individual handle for each socket wrench, as shown in Fig. 9-20*a*, or have a single handle and a set of sockets which snap on to the handle, as shown in Fig. 9-20*b*. The most useful sizes are 1/4, 5/16, 11/32, 3/8, and 7/16 inch.

Before you take the chassis out of the cabinet, decide where you are going to put it. If you wish to use a table in the customer's home, ask permission to do so. In order to avoid scratching the table, cover it with a protective pad. This pad may be made from a piece of heavy cloth or from newspapers. If the cabinet is a console type, the chassis normally rests on a shelf easily reached from the back of the cabinet; the screws that fasten it to the shelf are seldom difficult to get at and may be removed in any convenient order. If the cabinet is a table model, it is usually necessary to place the cabinet on a padded table in order to remove the chassis. It is a good idea to have a large rubber pad set aside in your workshop for this purpose. If you keep the pad clean and free from bits of solder and scraps of wire, you will be able to place cabinets on it with less danger of scratching the finish.

There are two good methods to use in removing the chassis from a table model cabinet. The first method is to lay the cabinet down on its *back* and remove the

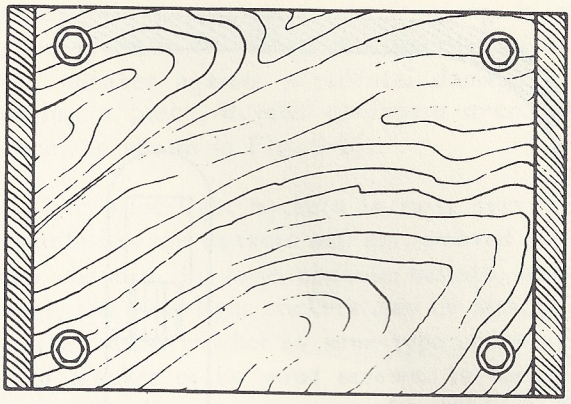


(a)



(b)

Fig. 9-20



bottom view of cabinet, showing mounting screws

Fig. 9-21

lower sets of screws first, as shown in Fig. 9-21. Do not remove the upper bolts first; the weight of the chassis may cause it to pivot on the lower bolts and become twisted out of shape. Hold the chassis with your hand while the last bolt is being removed. Then turn the cabinet upright and slide the chassis out by taking hold of some strong firmly attached part, like a power transformer. Depending upon the cabinet design and speaker location, it may be necessary to tip the chassis or turn it at an angle in order to get it out of the cabinet.

The second method is recommended when the chassis is too heavy to hold with one hand. With the cabinet upright, move it so that the screws at one side are exposed. Remove these screws from below, and then move the cabinet so that the remaining screws are exposed. Remove these screws, replace the cabinet firmly on the table, and slide out the chassis.

9-4. CLEANING THE CHASSIS

Even if the lady of the house is a careful housekeeper, the chassis and the inside of the cabinet will probably be pretty dusty. A thorough cleaning of the chassis and cabinet is one of the things that you should do on every repair job. A clean chassis is more pleasant to work on and will allow you to make a more careful visual inspection. In addition, dust collects moisture (which forms

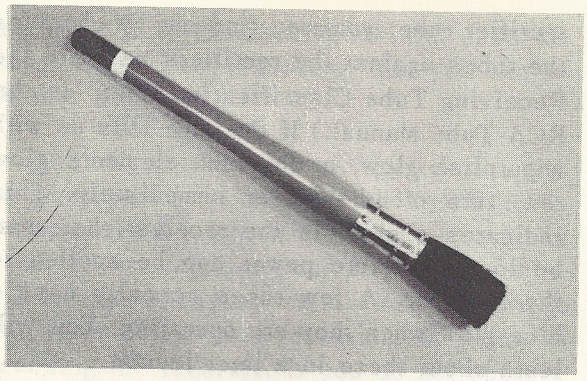


Fig. 9-22

electrical leakage paths) that may cause poor reception. For example, dust between two plates of the tuning capacitor will cause crackling noises as the receiver is tuned.

If the chassis is being taken to the shop, you should avoid cleaning it in the customer's home. If the repair is going to be completed in the customer's home, you should do the cleaning so as to cause as little mess as possible. A small brush or vacuum cleaner may be used for cleaning. A good brush for this purpose is shown in Fig. 9-22. Do your dusting in a well-ventilated area, and avoid inhaling the dust. A small hand vacuum cleaner is good for this purpose, since it does not stir up dust clouds. Carefully remove all dust from the tubes, chassis, and tuning condensers. Clean the dial scale and the inside of the dial window in the cabinet. Any grease or dirt that remains on the chassis can be removed with a brush or rag dipped in carbon tetrachloride. However, do not use carbon tetrachloride on dials or plastic windows; it may dissolve them. A liquid glass cleaner of the spray type is safer.

Caution: The vapors of carbon tetrachloride are poisonous. Use it only in a well-ventilated room, and do not inhale the vapors.

9-5. INSPECTION OF THE CHASSIS

Sometimes, before making any electrical tests, you can find the trouble in a receiver just by looking at it. Since your aim is to find the trouble and fix it as quickly as pos-

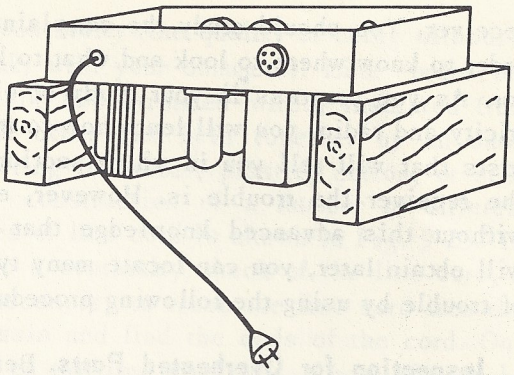


Fig. 9-23

sible, the first step in troubleshooting should be a careful, systematic, visual inspection of the chassis. This you can do without knowing much radio theory.

When you turn the chassis over to inspect its underside, be careful not to lay it down so that the tuning capacitor or other fragile parts will become bent. Have a number of assorted wooden blocks handy so that you can prop the chassis to a good working position with the tuning capacitor or other fragile part of the receiver kept clear of the table, as shown in Fig. 9-23. As the amount of your repair work increases, you may find it is worthwhile to get a commercial chassis holder, one type of which is shown in Fig. 9-24.

Just what should you look for? That depends, of course, on what is wrong with the

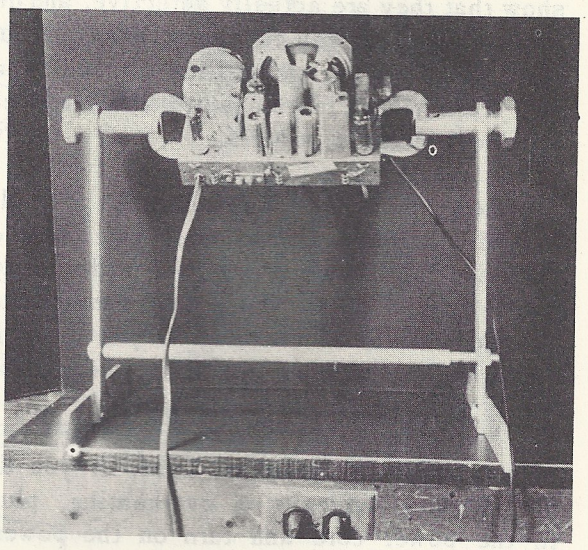
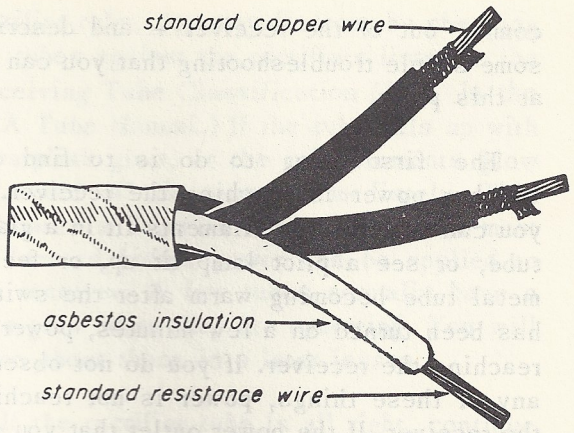


Fig. 9-24

cord that goes to the on-off switch. Touch the other test lead from the ohmmeter, first to one of the pins of the attachment plug and then to the other. The ohmmeter should deflect to zero ohms when the second test lead is touched to one but not both of the two pins of the plug. This indicates that this side of the line cord is *continuous* or unbroken. If the ohmmeter deflects when *both* pins are touched, the leads of the line cord are shorted out, and the line cord must be replaced. If the ohmmeter does not indicate a complete circuit with the test lead at one of the two pins of the plug, the line cord is open and should be replaced.

If one side of the line cord shows continuity, the other side should be tested. To do this, place one of the test prods of the ohmmeter on the end of the line cord that is *not* connected to the on-off switch and place the other test lead end of the meter on the pin of the plug at which no reading was obtained during the first test. A reading of zero ohms indicates that this side of the line cord is also unbroken. If a reading of zero ohms is not obtained, this side of the line cord is open, and the cord should be replaced.

Some line cords on older a.c.-d.c. receivers contain series-resistance wire wound inside the cord, as shown in Fig. 9-27. As the illustration shows, the resistor wire and one of the conducting wires are connected to one side of the attachment plug. The other conducting wire is attached to the remaining side of the plug. In most cases, the single conducting wire is connected to one side of the power switch, and this may be tested for continuity in the same way as you would test a power-cord conductor. The other conducting wire usually is connected to either a tie terminal or one of the pins of the tube socket and may be tested for continuity with your ohmmeter. The resistor wire, which is connected to the same pin, normally goes to one of the filament or heater terminals of one of the tubes. You can tell the resistor wire from an ordinary conductor by the fact that it is usually wrapped in asbestos insulation. So all you have to do



ac-dc resistance line cord

Fig. 9-27

is look for a white conductor that is part of the line cord. You can test this for continuity by placing one prod of your ohmmeter to the attachment-plug pin and the other test prod to the other end of the resistor wire. Because it is a resistor wire, your meter will register some value of resistance instead of going all the way to zero. Therefore, a reading that gives you some value of resistance shows that the resistor wire has continuity. If the meter needle does not deflect at all, it shows that the resistor wire is open and that the line cord must be replaced with another a.c.-d.c. resistor line cord of the same type. In a later Theory Lesson, you will learn how to calculate the value of resistance necessary for the correct operation of the receiver.

2. The on-off switch may be defective. With the attachment plug connected to the power outlet, you can check the switch quickly by shorting it out temporarily with a screwdriver across the two switch terminals, as shown in Fig. 9-28. Be careful to use an insulated screwdriver, and do not let the screwdriver touch the chassis or the outside casing of the switch when the screwdriver is in contact with the switch terminals. If the tubes light when the switch is shorted out with a screwdriver, but not when the switch is turned on, the switch is defective.

Caution: Do not let your hands or any other part of your body touch any of the exposed wiring or any part of the chassis as

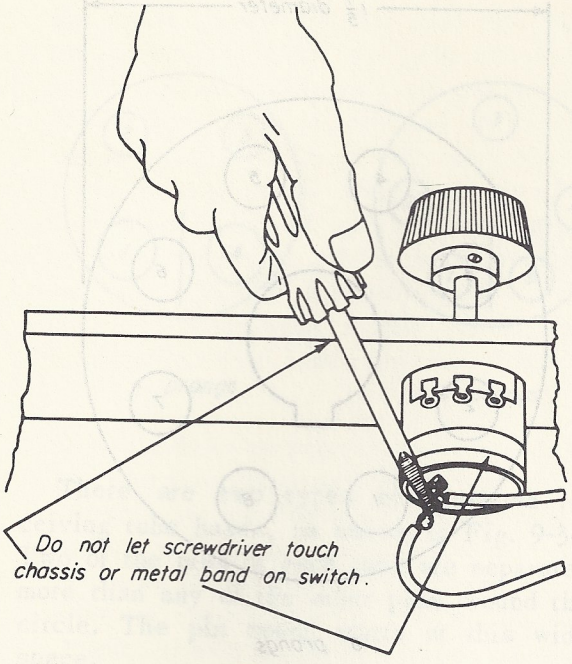


Fig. 9-28

you make tests while the chassis is connected to a source of power. In fact, while making most tests on a live receiver, a careful serviceman keeps one hand in his pocket. He does this to prevent himself from accidently completing the electrical circuit with his body. Figure 9-29 illustrates this.

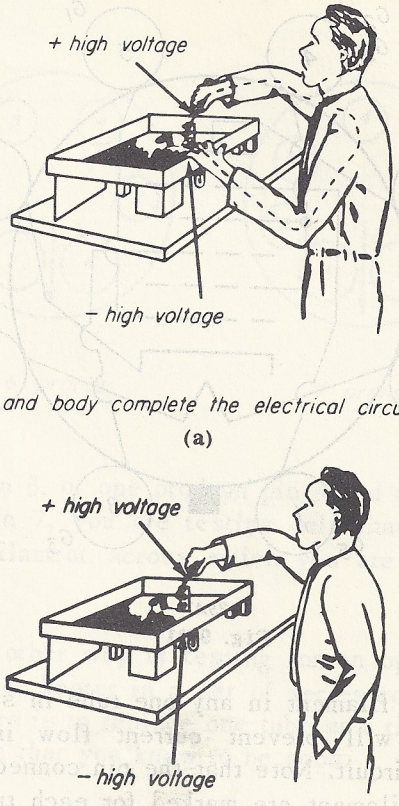


Fig. 9-29

3. If the receiver is of the a.c.-d.c. type with series connected filaments, one of the tubes may have an open filament. You can usually identify an a.c.-d.c. receiver by the fact that it does not have a power transformer and has one or more tubes whose filament voltage is 25 volts or higher. (Tubes are usually identified by a combination of letters and digits. The filament (heater) voltage of such tubes is given by the number before the first letter in the digit-letter combination. For instance, a 25Z6 has a 25-volt filament, a 35Z5 has a 35-volt filament and a 50L6 has a 50-volt filament.)

A simple series-connected heater circuit is shown in Fig. 9-30. As you have learned,

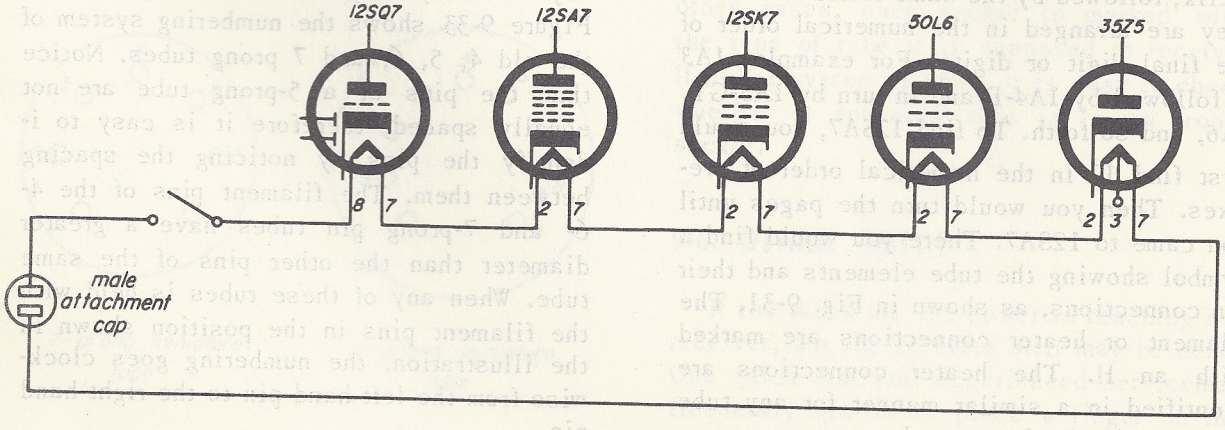
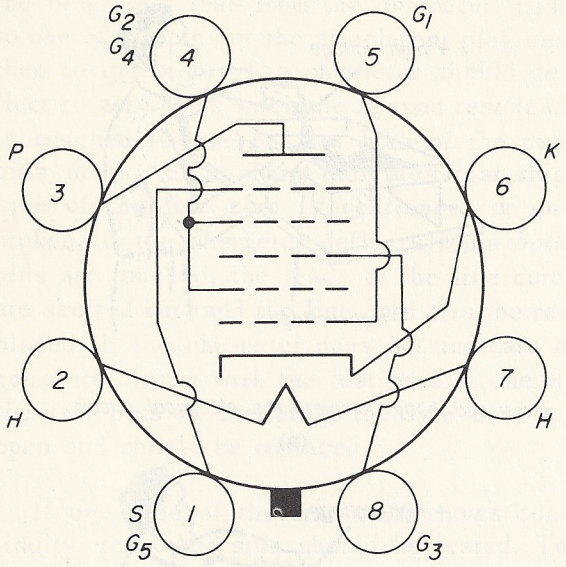
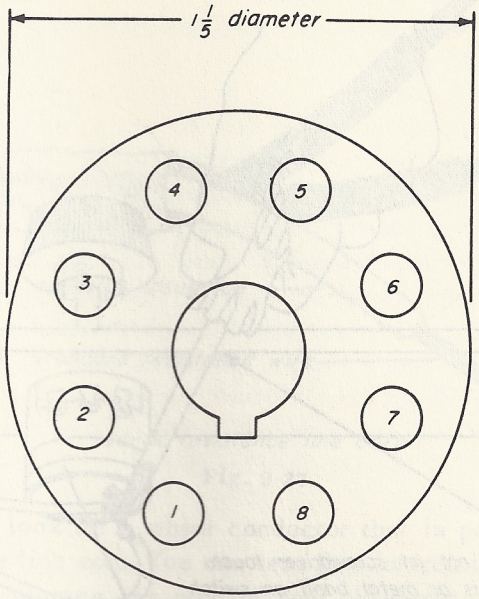


Fig. 9-30



12SA7
Fig. 9-31



8 prongs
Fig. 9-32

an open filament in any one tube in such a circuit will prevent current flow in the entire circuit. Note that the pin connections to the filament are marked for each tube in the circuit. If this information does not appear on the diagram, you can get it by using the RCA Tube Manual. In the RCA Tube Manual, each receiver tube is listed in the order of its numerical prefix, starting with 01-A to 886. Tubes with the same numerical *prefix* (that which appears in the first part of a word or number-and-letter combination) are arranged in the alphabetical order of their letter or letter-combination.

For example 1*AC*5 comes before 1*AD*5. Finally, if a tube has the same numerical prefix, followed by the same letter or letters, they are arranged in the numerical order of the final digit or digits. For example, 1A3 is followed by 1A4-P and in turn by 1A5-GT, 1A6, and so forth. To find 12SA7, you would first find 12 in the numerical order of prefixes. Then you would turn the pages until you came to 12SA7. There you would find a symbol showing the tube elements and their pin connections, as shown in Fig. 9-31. The filament or heater connections are marked with an H. The heater connections are identified in a similar manner for any tube that appears in the manual.

The pin connections to all receiver tubes are numbered in a clockwise direction, as you look directly at the pins and with the bottom of the tube facing you, as shown in Fig. 9-32. The 12SA7 has an *octal* base. This means that the base permits the use of up to 8 terminal pins. As the illustration shows, these pins are placed at equal distances around a large central pin. This central pin has a *key*, which is a ridge that runs along the center pin, that fits into a notch, called a *key way*, in the tube socket. The pins of octal tubes are numbered from this key. Starting with number 1 at one side of the key, the pins are numbered in a clockwise order to number 8 on the other side of the key. Lock-in type tubes have a similar key and key way and numbering system. Figure 9-33 shows the numbering system of the old 4, 5, 6, and 7 prong tubes. Notice that the pins of a 5-prong tube are not equally spaced; therefore it is easy to identify the pins by noticing the spacing between them. The filament pins of the 4- 6- and 7-prong pin tubes have a greater diameter than the other pins of the same tube. When any of these tubes is held with the filament pins in the position shown in the illustration, the numbering goes clockwise from the left-hand pin to the right-hand pin.

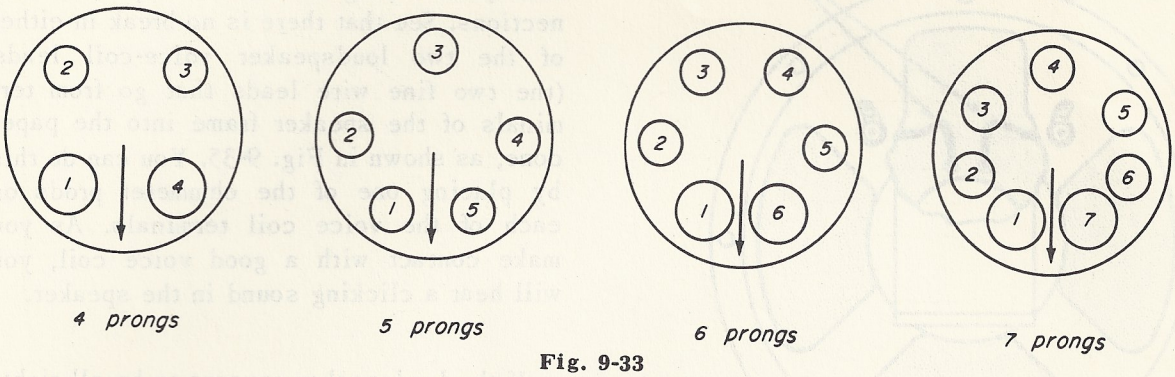


Fig. 9-33

There are two types of miniature receiving tube bases, as shown in Fig. 9-34. Two of the pins of each tube are separated more than any of the other pins around the circle. The pin count starts at this wide space.

You can check whether or not a tube has an open filament by connecting one test prod from the ohmmeter section of your multimeter to one heater pin and the other test prod to the other heater pin. If the heater is continuous, it will be indicated by the deflection of the ohmmeter needle. If the heater is open, there will be no ohmmeter reading. Sometimes filaments or heaters are tapped, as in the case of the 35Z5. In testing such tubes, it may be necessary to test across each section to the filament or heater to discover where the section is open. For example, in the case of the 35Z5, if you place one test prod on pin 2 and the other on pin 7, you are testing the entire filament. If you place one test prod on pin 2 and the other on pin 3, or one prod on pin 3 and the other on pin 7, you are testing only that part of the filament across which you are connected.

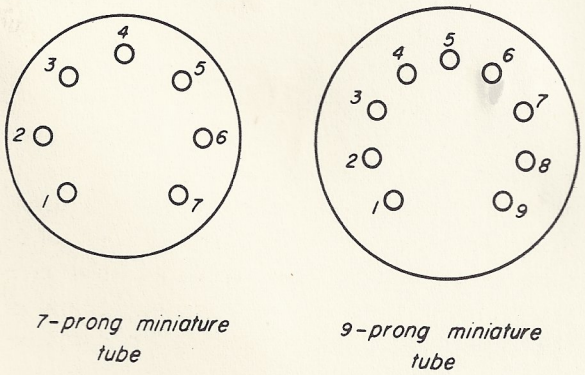


Fig. 9-34

Another way of testing for an open filament or heater in a set of series-connected heaters is to replace one tube at a time with a tube that you know to be good.

Caution: Do not use this method when testing battery portable receivers that also operate from either an a-c or d-c power line. In some such sets, you may burn out each new tube that you use to replace an old tube.

4. Two or more tubes may be placed in the wrong sockets. In many radio receivers and radio-phono combinations, the proper layout of the tubes is shown in a diagram pasted to the back of the chassis, to the inside of the cabinet (in consoles), or to the bottom of the cabinet (in table models). In other cases, each socket is marked with the type of tube it is supposed to receive. If either system is used, it is easy to check whether or not each tube is in its proper socket.

9-6. OTHER TESTS

If the tubes are lit, power is reaching the receiver, but the receiver still may be dead. One quick test that experienced servicemen frequently use is to place a finger on the center tap of the volume control with the

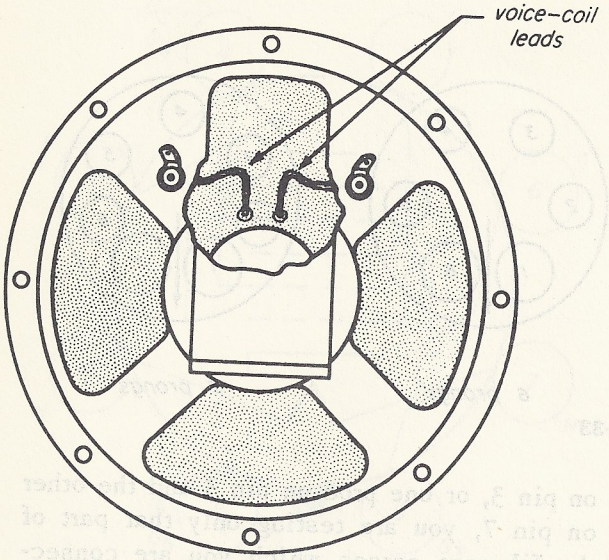


Fig. 9-35

control turned to the maximum volume position. This should produce a fairly loud low-pitched buzzing sound. Later in this course, you will learn how valuable this test is. It shows that the most important trouble is either before the audio section of the receiver (where the audio signals are amplified and reproduced by the loudspeaker). So, if you hear such a buzzing sound, you will know that the audio section of the receiver is probably not at fault but that the trouble is before the audio section. However, if you do not get this buzzing sound, check the loudspeaker plug and the loudspeaker connections. See that there is no break in either of the two loudspeaker voice-coil leads (the two fine wire leads that go from terminals of the speaker frame into the paper cone, as shown in Fig. 9-35. You can do this by placing one of the ohmmeter prods on each of the voice coil terminals. As you make contact with a good voice coil, you will hear a clicking sound in the speaker.

If the loudspeaker appears to be all right, examine the tuning capacitor plates to see if any of the movable plates are touching any of the stationary plates and causing a short. You can check this by turning the capacitor plates so that the movable plates are completely separated from the stationary plates. This will remove the short if one existed, and a rushing noise will be heard in the loudspeaker. Also examine the connections to the loop antenna or outside antenna to see if they are broken. If these check all right, the next thing to do is to check the tubes, either by replacing them with good tubes or by testing them on a tube checker. In many cases, you will have found the trouble by the time you have completed these simple checks.

ELECTRONIC FUNDAMENTALS

SERVICE PRACTICES 10

HOW TO TEST TUBES

10-1. Electron-Tube Construction

10-2. Electron-Tube Defects

10-3. Methods of Tube Testing

10-4. Tube Substitution

10-5. Recommended Tube List

10-6. Tube Testers

10-7. Buying A Tube Tester

RCA INSTITUTES, INC.

A SERVICE OF RADIO CORPORATION OF AMERICA

HOME STUDY SCHOOL

350 West 4th Street, New York 14, N. Y.

Service Practices 10

INTRODUCTION

A majority of the troubles in radio and television receivers are due to electron-tube failure. Electron tubes are liable to fail more often than any other parts in the receiver because they operate at very high temperatures and they are constructed of very delicate and fragile parts that are very closely spaced in the metal or glass container, or *envelope* of the tube. In this lesson, you will learn two methods of testing tubes and something about the construction and theory of operation of electron tubes.

10-1. ELECTRON-TUBE CONSTRUCTION

Most electron tubes consist of four major parts, or *elements*, as they are called. Figures 10-1 and 10-2 show two ways in which these elements may be arranged. The major parts or elements are:

1. A *filament* or *heater*, which is a loop or coil of fine wire or ribbon, somewhat similar to the filament in an electric-light bulb. When current flows through it, the filament becomes heated. The heat causes electrons to be given off or *emitted* from the surface of the filament. The process by which metals *give off* electrons when heated is called *electron emission*. In some tubes, the electrons are emitted directly from the filament. The construction of a typical tube of this type is shown in Fig. 10-1. In most tubes, however, the supply of electrons is obtained from a cathode.

2. The *cathode*, which is a metallic sleeve that surrounds the filament, and is heated by it. It is chemically coated with substances that, when they are heated, readily emit electrons. The construction of a typical tube using a cathode is shown in Fig. 10-2.

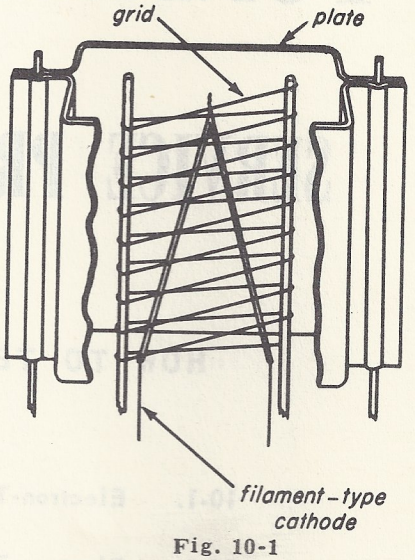


Fig. 10-1

3. The *grid*, which is a fine wire screen whose purpose is to control the flow of electrons in the tube. In most receiving tubes, the grid is constructed of wire that is finer than human hair, and it is placed very close to the other tube elements. Most tubes have one or more grids, but some tubes,

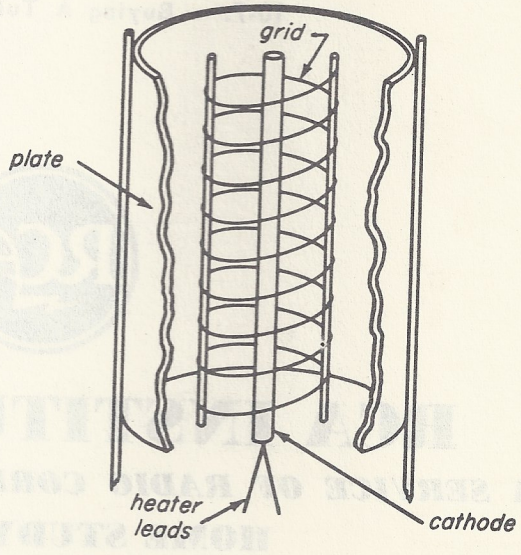


Fig. 10-2

such as diodes or rectifier tubes, do not have any grids at all.

4. The *plate*, or *anode*, which is a metal structure, either in the shape of a cylinder, as in Fig. 10-1, or in the shape of a rectangle, as in Fig. 10-2. Its purpose is to receive or collect the electrons that have been emitted from the filament or cathode of the tube.

Many tubes are multi-purpose tubes; that is, they may have several grids, plates, or other elements in one envelope.

10-2. ELECTRON-TUBE DEFECTS

By looking at Fig. 10-3, which shows the construction of a modern miniature glass receiving tube, you will get some idea of the complicated and delicate structure of modern electronic tubes. Such tubes operate at temperatures of several hundred degrees. The tube elements are very fragile and very closely spaced. It should not be surprising therefore, that a great many defects may develop in electron tubes. These defects may cause the tubes either to stop operating,

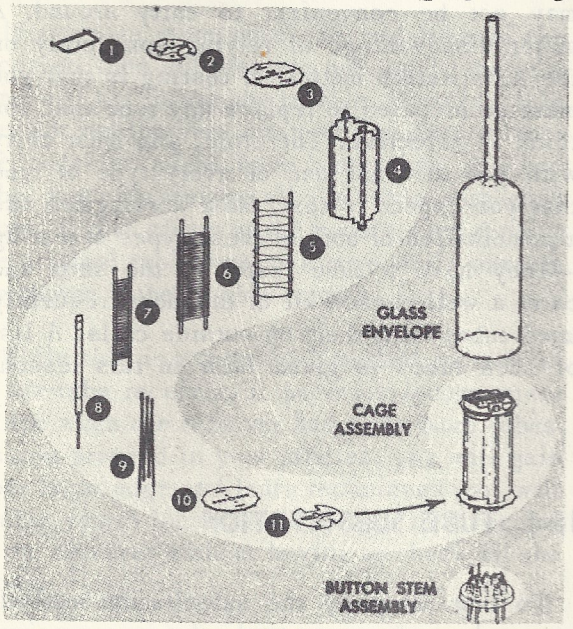


Fig. 10-3 The Parts of a Miniature Pentode

have reduced or insufficient output, become *intermittent* in their operation, or introduce distortion into the output signal.

These defects are as follows:

1. *Open filament.* The filament wire may open due to age, mechanical shock, or poor connections so that there is no longer a complete circuit for current flow through the filament. The filament cannot become heated, and a supply of electrons for the operation of the tube is not introduced. If the tube is in a series-filament circuit, or *series string* as it is called, the open filament will prevent current flow in each of the tubes.

Occasionally, the filament breaks, but in such a way that the two ends of the filament at the break touch while the filament is cold, thus allowing current to flow through it. However, as soon as the filament is heated by the current flow, it expands, and the two ends at the break separate. The circuit is opened, and the current stops. After a while, the filament cools, the ends touch again, and the cycle starts over again. Thus, the filament blinks on and off.

2. *Low emission.* This condition occurs when the filament or cathode can no longer supply the amount of electrons necessary for the operation of the tube. When the emission of the tube begins to fall off, the output of the tube is reduced, until finally the tube must be replaced.

3. *Inter-element shorts.* Due to loose connections, rough mechanical handling, or loose particles inside the tube, an unwanted connection may occur between the various elements of the tube. If the unwanted connection between the elements has a low resistance, it is called a *short*, or *direct short*. If the unwanted connection between the elements has a high resistance, we say that there is *leakage*, or *high-resistance short*, between the elements. Such shorts interfere with the operation of the tube and usually make it necessary for the tube to be discarded. In amplifier tubes using a heater and

cathode, leakage between these two elements may cause the 60-cycle a-c heater voltage to leak to the cathode and cause hum in the output of the receiver. Sometimes a short occurs only after the tube has been in operation for several hours, or only if the tube is tapped, or a combination of these conditions. Methods for finding all of the various kinds of shorts will be described later in this booklet.

4. *Microphonics.* This term is used to describe a tube in which the elements are loose enough to shake or vibrate and cause undesirable noises in the output.

5. *Gassy tubes.* Most electron tubes in radio receivers have a very high vacuum inside the tube envelope; that is, as much of the air as is practicable is removed from the tube envelope before it is sealed. A very small amount of air in the tube will interfere with the proper operation of the tube. A tube with air in it is called gassy.

If more than a very small amount of air enters the tube, the filament will burn out almost immediately, making the tube useless. This condition can be recognized by the milky-white coating that can be seen on the inside of glass tubes.

6. *Open element connections.* Connections to tube elements are made by wire leads. The connection between the lead and the element is usually made by a spot weld. Due either to mechanical shock or repeated expansion and contraction, these connections may open. The connection either may remain open permanently or it may be open only while the tube is hot. Sometimes, due to improper tube operation or defective circuit components, too much current may flow in one of these leads and burn it out, opening the connection to one of the elements. This happens most frequently in *rectifier* tubes, in which a short circuit in the receiver burns out the connection at the cathode, called the *cathode tab.*

7. *Open Elements.* The elements of an electron tube are connected to tube pins in the base of the tube by wire leads. These leads are soldered into the base pins. Sometimes these solder connections may open up and cause either *intermittent* operation or failure of the tube.

10-3. METHODS OF TUBE TESTING

There are two general methods of testing tubes. One is the *substitution* method, where a tube of the proper type that is known to be good is substituted for a suspected tube in a receiver. If the trouble disappears when the test tube is in the socket, the suspected tube probably is defective. You will learn about one or two cases in which this is not true later in this lesson.

The other method of testing tubes is the *tube tester* method. Tubes are tested by specially designed testing instruments called *tube-testers* or *tube checkers.*

There are some advantages and disadvantages to both methods. The greatest advantage of the substitution method is that a tube tester is not needed. Tube testers are expensive and may not be convenient to carry around. A major disadvantage of relying completely on the substitution method of testing is that you must be prepared to replace any tube that you think is defective. Therefore, you must carry with you at least one of every type of tube that you expect to test. Most servicemen use a combination of both of these types of testing —they have a tube tester in the shop and carry a well-chosen kit of the most frequently used tubes with them on outside calls. A list of such tubes is given later in this lesson.

10-4. TUBE SUBSTITUTION

To test tubes by the substitution method, you replace the suspected tube in a receiver with a good tube of the same type number. After allowing sufficient warm-up time, you see whether the trouble has been removed and the receiver operates normally. If it does, then

the tube that the test tube has replaced is defective. If it does not, replace the original tube, and substitute a good tube for each of the other of the tubes in the receiver until either a defective tube is found, or all of the tubes check good. Turn the receiver power switch off each time before changing tubes. Substitute one tube at a time, and replace the original tube before going on to the next one. This will prevent you from getting tubes back into the wrong sockets. By means of other tests which you will learn later, you will usually be able to *localize* the trouble to a certain section of the receiver so that only a few tubes have to be tested. However, if you cannot localize the trouble to a certain section of the receiver, you will have to test all of the tubes.

Some servicemen like to keep a set of testing tubes especially for this purpose. They label them in some distinctive way so that they can easily be recognized and not left in the customer's receiver. If they locate a defective tube with the test tubes, they remove the test tube and replace the defective tube with a brand new tube from stock. In this way, they do not have to open a new tube carton for a test tube and then put the tube back if that tube is not used.

If there is more than one bad tube in the receiver, then substituting one good tube at a time will not locate the trouble. However, this may not happen very often. If you suspect that the receiver might have more than one bad tube, you can replace all the tubes with good tubes. If this clears up the trouble, then replace the original tubes one at a time while observing to see if the trouble returns.

While this is a practical method for a five- to six-tube receiver, it becomes inconvenient to use when the receiver has many more tubes. As you proceed in your studies, you will gain more knowledge and learn techniques that will enable you to localize the trouble to a section of the receiver without having to check all the tubes.

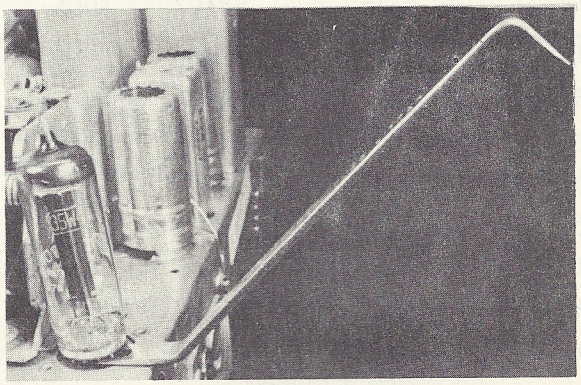
There are certain precautions to keep in mind when using this method of tube testing:

Do not substitute tubes when there is danger of damage to the test tube. If you see the plates of a tube glowing red, or see any other signs of overheating, it is best to investigate and locate the source of the trouble before substituting new tubes.

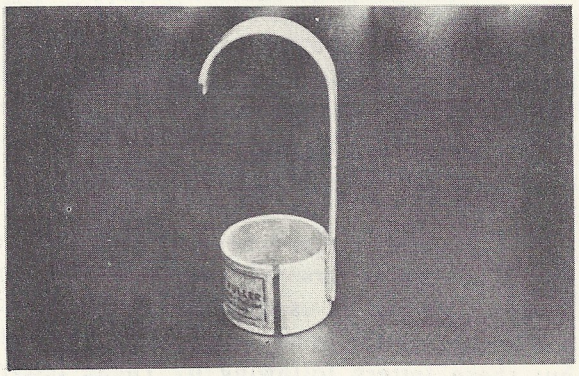
Special precautions must be taken before substituting tubes in a three-way or battery portable. These will be described in the lesson on these receivers.

Since many tubes become hot enough to burn the fingers, a tube puller or lifter is a useful device for removing hot tubes or tubes located in tight places on the chassis where there is not room for fingers. Figure 10-4*a* shows a lifter for miniature glass tubes, and Fig. 10-4b shows a tube puller for standard-size metal and glass tubes.

In certain circuits, a tube may not operate even though it is a good tube. This is the exception that was mentioned earlier in connection with tube substitution. Such tubes should not be discarded, but saved for use in other circuits. Examples of such circuits will be given in later lessons.



(a)



(b)

Fig. 10-4

10-5. RECOMMENDED TUBE LIST

Relying upon tube substitution alone for testing tubes requires that the serviceman have at least one of every tube type that he is likely to come across. While it is possible to have such a stock of tubes in the shop, it is not practical to take so many tubes on outside calls.

The list in Table A is a guide to the tubes most frequently used in home and portable radio receivers. We asked the head of one of the largest radio and television service organizations in the country just which tubes a man should carry on service calls. He sent us the list in Table A. From this list, you can tell which tubes to carry with you on outside calls. Also, since it represents the most frequently used tubes, it can guide you in ordering stock for your shop.

TABLE A – FREQUENTLY USED TUBES

1R5	6AU6	6X5-GT	35Z5-GT
1T4	6AV6	12AT6	50B5
1U4	6BA6	12AV6	50C5
1U5	6BE6	12BA6	50L6-GT
3S4	6J5	12BE6	
3V4	6K6-GT	12SA7	
5U4-GB	6SA7	12SK7	
5Y3-GT	6SK7	12SQ7	
6AL5	6SQ7	25L6	
6AQ5	6V6	25Z6-GT	
6AT6	6X4	35W4	

Bear in mind, however, that this list refers to tubes used in radio receivers and radio-phono combinations. While some of them are used in television receivers, many other tubes in addition to these must be carried by the television serviceman.

As a general rule, a tube which has the letter G or the letters GT following the tube designation may be used as a replacement for a tube having the same designation but without these letters following it. These letters describe the type of envelope that the tube has. For example, tube types 6F6, 6F6-G, and 6F6-GT are all the same electrically, except for minor details. Type 6F6 is in a metal envelope, as shown in Fig. 10-5a, type 6F6-G is in a large glass envelope, as shown in Fig. 10-5b, and type 6F6-GT is in a small, straight-sided glass envelope as shown in Fig. 10-5c. In most home radio receivers, any one of these may be used for a replacement for one of the others.

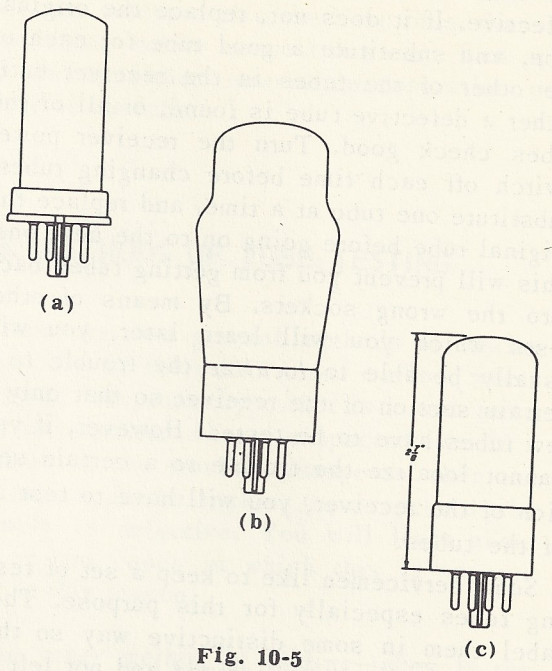


Fig. 10-5

In substituting one tube for another, such as a glass tube for a metal tube, there is one very important point to remember. Pin 1 of a metal tube is connected to the metal shell of the tube. In a receiver, the socket terminal that connects with pin 1 is grounded to the chassis, and the circuit in which the tube operates is designed to take advantage of the shielding effect that results from these connections. If a glass tube is substituted for a metal tube, there will be no shield or connection to pin 1. Without a shield, the circuit may become unbalanced and cause the circuit to operate improperly. In such cases, only a metal tube will give satisfactory service.

Several tube manufacturers are now producing certain heavy-duty tubes, which are similar to but more rugged than the regular types.

These are designated by an additional letter A, B, or C. An example of this is the regular type 5U4-G rectifier tube, and the types 5U4-GA and 5U4-GB. The GA and GB types may be used to replace a regular type 5U4-G. However, the regular type may overheat excessively when it is used to replace one of the more rugged types, depending upon the circuit it is being used in.

10-6. TUBE TESTERS

Although tube substitution is a very reliable method of testing tubes, there are many reasons why a tube tester is a valuable piece of test equipment for the technician to have. The tube tester can do the following:

1. Test tubes that are not in a receiver, as when a group of tubes are brought in by a customer for testing.

2. Test every receiving tube and many special-purpose and industrial tubes.

3. Enable more accurate comparisons to be made between tubes. A well-designed tube tester can give an estimate of useful life to be expected from a tube, and thus point out those tubes that are going bad.

4. Provide a "Good-Bad" scale or similar scale (sometimes called an *English reading* scale) to show the condition of the tube to non-technical customers.

Types Of Tube Testers. A tube tester is a test instrument that applies certain voltages to all or some of the elements of an electron tube and measures the current flow. The amount of current flowing is used as a measure of the quality or condition of the tube. Most tube testers also check tubes for other defects, such as interelement shorts, leakage, microphonics, and gas. Such defects are shown either by deflection of the tube-tester meter or by neon-lamp indicators.

A typical scale used with tube testers is shown in Fig. 10-6. About half of the scale is labelled BAD or REPLACE, and the other half is labelled GOOD. The good section usually is colored green and the bad section usually is colored red for easy identification. Between these two sections, there is usually a

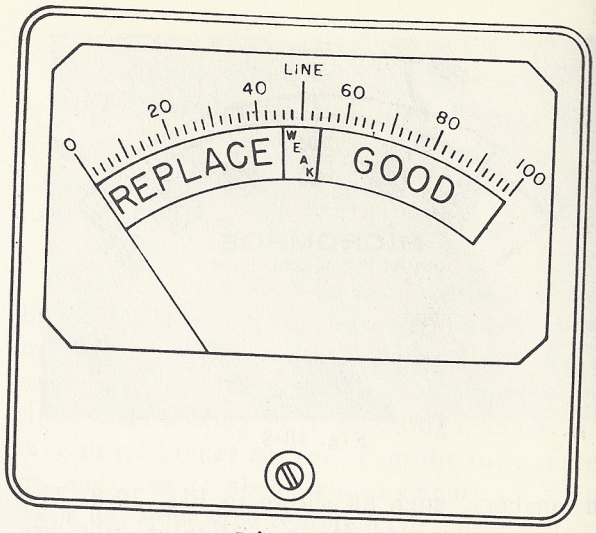


Fig. 10-6

small section labelled with a question mark, or WEAK. A tube tester reading in this section indicates that the condition of the tube is doubtful. Whether or not such a tube should be replaced depends upon the use to which the tube is put and the judgment of the technician. Some testers also have a small red or doubtful section at the extreme right of the meter scale, as shown in Fig. 10-7. The purpose of this section is to call attention to tubes that appear to test extremely good; that is, they cause the tube tester meter to deflect all the way to maximum. A tube that appears to give an abnormally high reading is probably as bad as one which gives a low reading, because such high readings may be due to either gas or shorted elements within the tube.

Some tube testers do not have an English reading (Bad-Good) scale, but are calibrated

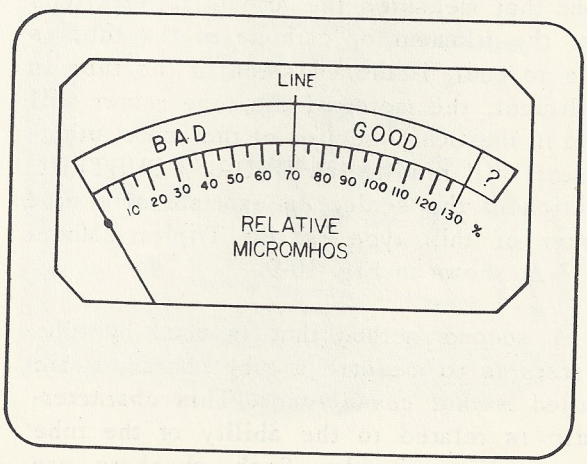


Fig. 10-7

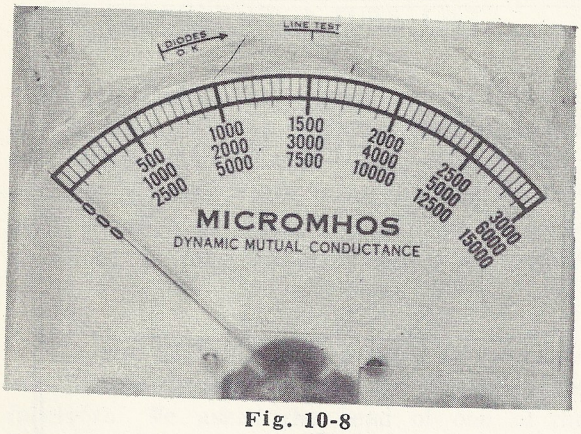


Fig. 10-8

in numbers, such as shown in Fig. 10-8. The readings obtained for a particular tube are compared with the figure given in the tube-tester chart to see whether the tube is good or bad. Many tube testers may have both of these scales, and the serviceman may use whichever is more convenient.

A number of tube testers are also designed to be used as volt-ohm-milliameters, or similar analyzers, and therefore the meter scale may resemble that of a volt-ohm-milliameter plus an added tube-tester scale.

There are three general methods by which tube testers determine the condition of a tube. We will briefly describe the three principles involved. You will learn more about them when you study the Theory Lessons on electron tubes and their applications.

The first method is *emission testing,* and tube testers using this method are called *emission testers.* They use a circuit arrangement that measures the amount of electrons that the filament or cathode of the tube is able to emit. If the emission of the tube is sufficient, the meter of the tube tester will read in the GOOD section of the scale; otherwise it will read in the BAD or DOUBTFUL section of the scale. An example of a tube tester of this type is the Triplett Model 3413-A, shown in Fig. 10-9.

A second method that is used by tube testers is to measure a tube characteristic called *mutual conductance.* This characteristic is related to the ability of the tube to amplify signals. Such checkers are

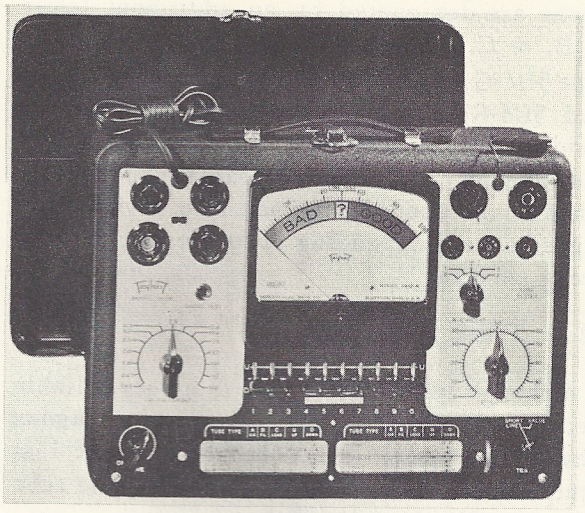


Fig. 10-9

called mutual conductance checkers. A typical tube tester of this type is the Hickok Model 600A shown in Fig. 10-10.

The third method that is used by tube testers is based on a circuit arrangement that measures the power output of the tube with a certain fixed signal applied to the control grid of the tube. A tube tester of this type is the Precision Series 10-12 shown in Fig. 10-11.

Most tube testers use one of the three methods that have been described to judge the condition of the tube. Some testers combine two of these tests to make a more complete composite test for judging the condition of tubes.

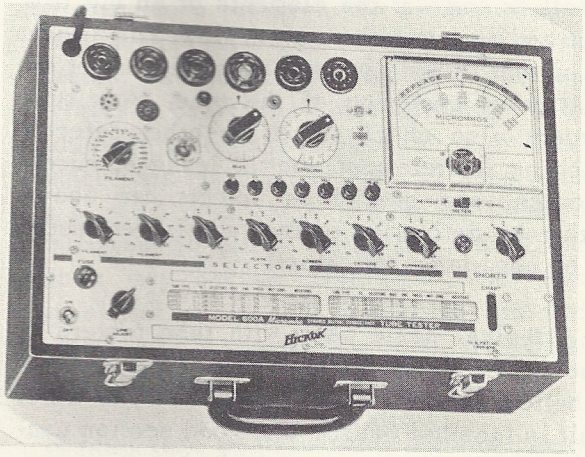


Fig. 10-10

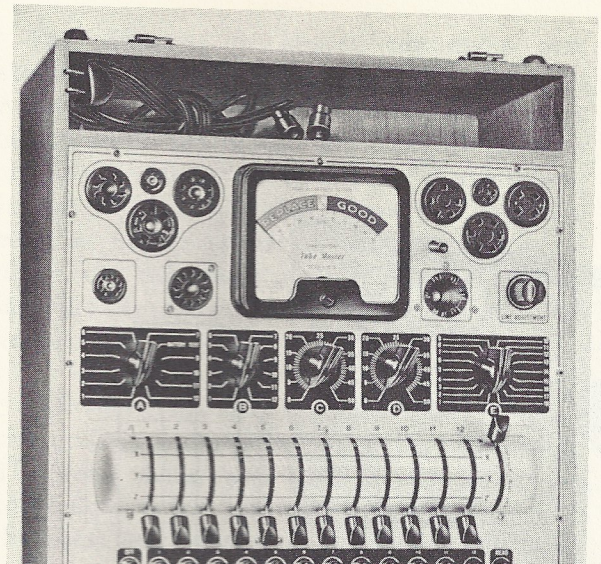


Fig. 10-11

Diodes and rectifier tubes, which do not have grids, are tested by the emission test method on all tube testers.

Using The Tube Tester. The following general information applies to the testing of any tube in any tester. The next section describes how to test a tube on a typical tester, the Hickok Model 605A shown in Fig. 10-12.

Before attempting to check tubes on any tube tester, read the instructions for the particular model that you have. Some testers have enough instructions on the front panel to tell how to use that tube tester. For other testers, it is necessary to read the instruction book for a particular model. Be sure you know how to use the tube tester before you proceed.

To test a tube on the tube tester, it is necessary to make a half-dozen or more settings of switches, dials, or pushbuttons. The information for making these settings is obtained from a roller chart that can be seen on the top of the tube tester. Occasionally, the tube information is contained in booklet that comes with the tube teste

These settings must be made before any tub is inserted in its socket on the tube teste otherwise damage to the tube may result.

To test a tube, look up the tube designatio in the chart and make the settings called fo by the chart. This means setting the dials switches, or pushbuttons to the proper posi tion. After making all the settings, insert th tube in its proper socket. Turn the tube teste on and give it about a half minute or so t warm up. Most tube testers have a line-voltag adjustment provision to compensate for dif ferent supply voltages and the different cur rents drawn by various tubes. The line-volt age adjustment is made at this point, i accordance with the instructions for the par ticular tester that you are using.

The tube testing procedure usually con sists of several tests and they should be made in this order:

1. Filament or heater continuity check
2. Short tests
3. Quality tests
4. Gas test
5. Noise and microphonics
6. Special tests

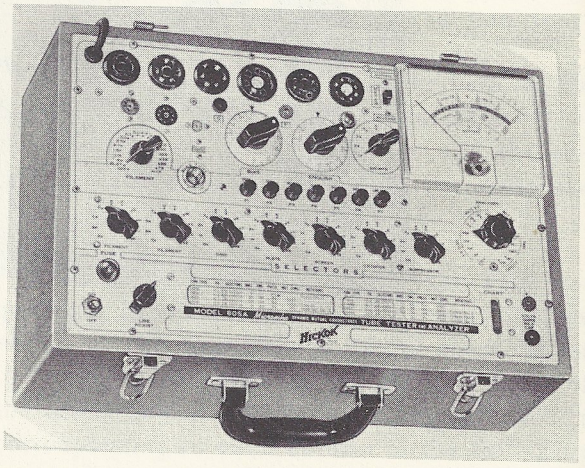


Fig. 10-12

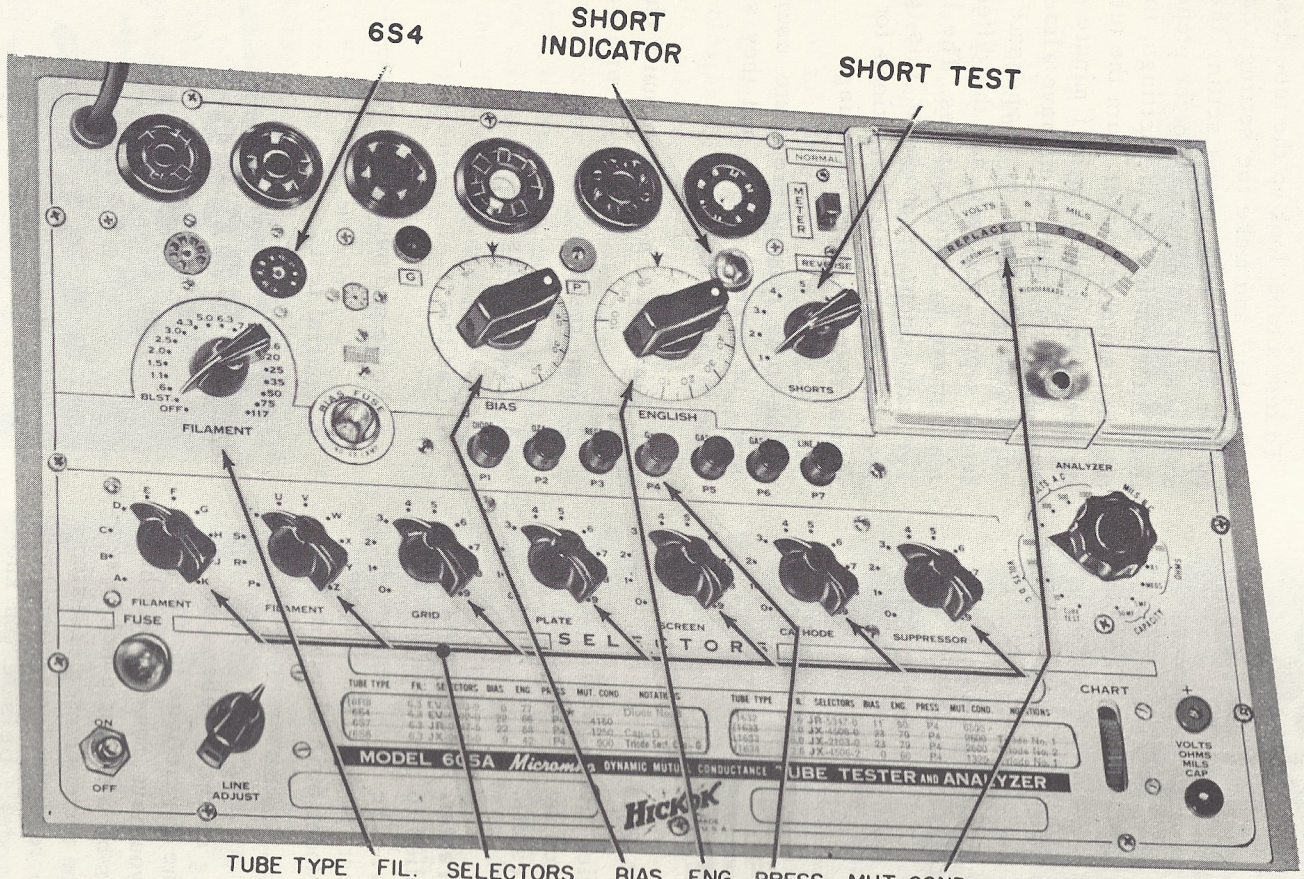

6S4
SHORT INDICATOR
SHORT TEST
FILAMENT
BIAS
ENGLISH
SHORTS
ANALYZER
CHART
FUSE
GRID
PLATE
SCREEN
CATHODE
SUPPRESSOR
LINE ADJUST
OFF
VOLTS OHMS MILS CAP
MODEL 600A
TUBE TESTER AND ANALYZER
TUBE TYPE
FIL.
SELECTORS
BIAS
ENG.
PRESS
MUT. COND.
NOTATIONS
6S4
6.3
EV-6902-0
22
86
P4
4150

Fig. 10-13

The filament or heater continuity test shows whether the filament or heater is good. A neon bulb is used as the indicator on most tube testers; the tube-tester meter is used on others. Of course, in the case of glass tubes, it can be seen immediately whether the filament or heater is lit; in the case of metal tubes, the continuity test saves some time by immediately showing whether the filament or heater is good or bad.

The short test shows whether there are any connections between the elements of the tube. The same neon lamp that is used for the continuity tests indicates shorts. To make the short test, various levers or pushbuttons are depressed, and the neon lamp will light if there is a connection between elements. In certain tubes, there is a connection between certain elements, and there will be a note next to that tube in the tube chart that the neon lamp should glow. If there is no such note and the neon lamp glows, an undesired connection or short exists between elements. *Do not make any further tests on a shorted tube, or damage to the tube tester may result.* Only if a tube passes the short test should the remaining tests be made. The tube being tested should be tapped lightly with the eraser of a pencil while the short test is being made. Flashes in the neon lamp indicator show that intermittent shorts between the elements exist. Such a tube will probably cause noise or erratic operation in the receiver, or develop a permanent short soon.

The quality check of the tube is made by one of the three methods previously described, depending upon the tube tester being used. When the proper buttons or switches are operated, as specified in the instruction manual for the tester, the meter will indicate the condition of the tube. Depending upon the tube tester, the reading may be either on a Good-Bad scale or on a scale calibrated in micromhos. Tubes that give a reading in the Bad section of the scale should be replaced. Tubes reading in the doubtful or weak section of the scale may be used, but preferably should be replaced to avoid future trouble. If the tube tester is calibrated in micromhos, any tube giving a reading of less than 70% of the value given in the chart should be replaced.

Many tubes contain two or more sections i one envelope. Each section of such a tub must be individually tested, both for short and quality. The tube-tester chart will cal attention to two such tubes by having two o more sets of settings for them. To test multisection tube, make all the settings fo the first section, and test the tube. Then tur the tube tester off and make the settings fo the other section. After all the settings hav been made, turn on the tester and make a the tests on the other section. Proceed in thi way until all the sections of the tube ar tested. Many tube tester manufacturers mak provisions in their tube testers for estimatin the useful life of a tube. This is done by re ducing the filament or heater voltage by som predetermined amount, and making a quali test of the tube at this reduced filament vol age. In accordance with the instruction given, the technician may then estimate th expected life of the tube.

Using The Hickok Model 605A Tube Teste

In this section, we will describe in deta how to set up a number of typical tubes on representative tube tester. We will show ho to test a type 6S4 tube on a typical tub tester, the Hickok Model 605A tube teste which is shown in Fig. 10-12. Most oth tube testers have similar set up procedure The procedure is as follows:

1. Turn on the tester and allow it to wa up. Do not insert the tube into its socket. S the ANALYZER switch, which is directly b low the meter, to the TUBE TEST positio

2. Turn the roller chart until the data for 6S4 type tube is visible. An enlargement this portion of the roller chart and the e graved labels which appear on the case shown at the bottom of Fig. 10-13.

3. The 6S4 is a miniature glass tube quiring a filament supply of 6.3 volts. This shown by the first column of the chart, un the heading FIL. Set the FILAMENT knob the tester to 6.3. The location of the contr corresponding to each column of the roll ch are indicated on Fig. 10-13 by arrows c necting the roll chart label to the correspo ing control.

4. The next column of the roll chart is labelled SELECTORS. The selectors are the seven pointer knobs running across the center of the tube tester. Under the heading SELECTORS on the roll chart, there are the letters EV and the numbers 6902-0. These seven letters and numbers are the settings, from left to right, for the seven pointer knobs, as shown by the arrows. The first selector knob is set at E, the next at V, the third at 6, the fourth selector knob at 9, the fifth at 0, the sixth at 2, and the last at 0.

5. The next column of the roll chart is labelled BIAS. The location of the bias potentiometer is shown by the arrow from the bias column of the roll chart. For the 6S4 tube, the bias setting is 22. The bias potentiometer is set to 22. The bias potentiometer is calibrated from 0 to 100. Each small division of the bias scale is one unit.

6. The next column on the roll chart is labelled ENG., which is the abbreviation for English. The location of the English potentiometer is shown by the arrow. This potentiometer has a scale similar to that of the bias knob, where each small division on the scale is one unit. The English setting for the 6S4 tube is 86, and the English pointer is set at 86.

7. After all the settings are made, the tube is inserted in the proper socket. The 6S4 is a nine-pin miniature glass tube, and the proper socket is shown by the arrow.

8. Set the line voltage by holding down the pushbutton P7 and adjust the LINE ADJUST knob until the meter pointer is exactly over the LINE TEST mark at the center of the scale. This establishes standard voltages for testing the tube.

9. The SHORTS switch has six positions. The first five are used in testing the tube for shorts. The sixth position, TUBE TEST, is used when testing for mutual conductance. USE THE TEST POSITION ONLY IF THE TUBE HAS NO SHORTS. Turn the shorts switch through positions 1-2-3-4-5 while gently tapping the tube with a pencil eraser and watch the neon-lamp short indicator. Shorted elements in the tube will cause the neon lamp to glow. A momentary flash of the neon lamp as the switch is turned from one position to the next should be disregarded. A shorted tube should be discarded without further test. Note the position of the switch at which the neon lamp glows. Look up these positions in the instruction book to find out which elements are shorted.

If the tube passes the shorts test, it should be tested for mutual conductance. Turn the SHORTS switch to the TUBE TEST position. Press the P4-GM push button and read the meter. The tube tester meter will indicate the quality of the tube on the ENGLISH READING, or GOOD-BAD, scale.

To obtain the mutual conductance of the tube in micromhos, the English potentiometer is *not* set according to the figure given under the English column of the roll chart, but is set to one of three red dots on the English potentiometer scale according to the mutual conductance reading expected. On the tube-tester portion of the meter scale, shown separately in Fig. 10-14, there are three ranges: a 0-3000 micromho range, a 0-6000 micromho scale, and a 0-15000 micromho scale. According to the roll chart, the average mutual conductance of a 6S4 tube is 4150 micromhos. Therefore, the second range of the meter should be selected by setting the appropriate dot on the English potentiometer alongside the pointer. When the P4-GM pushbutton is depressed, the meter will indicate the mutual conductance of the tube in micromhos. If the meter reading is less than 70% of the chart value, the tube should be replaced.

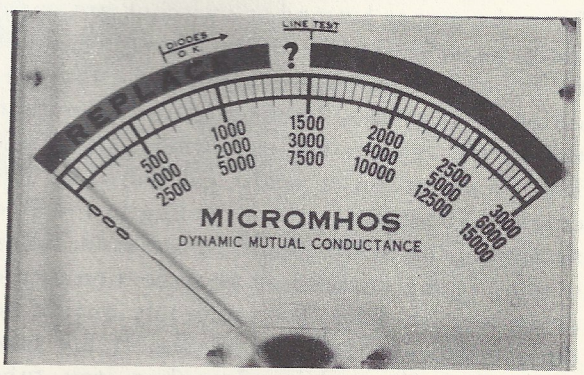


Fig. 10-14

When reading mutual conductance in micromhos, the REPLACE-GOOD scale is disregarded. An estimate of the expected life of a tube can be made, in accordance with the manufacturers instructions, in this manner:

1. Measure the mutual conductance of the tube in the usual manner.

2. Press the GM button on the tube tester and adjust the ENGLISH dial until the meter reads at 2000 on the 0-3000 micromho scale.

3. Reduce the filament voltage to 75% of the rated value (using the nearest step on the filament-voltage selector switch). If the meter still reads in the green (GOOD) section of the scale, the tube has a large life reserve. Of course, you must still use considerable judgment, taking into consideration the type of service in which the tube is being used, to decide whether tubes should be replaced on the basis of such tests.

Testing Multi-Section Tubes. Many tubes actually contain two or more tubes within one envelope. A type 6SN7 tube, for example, contains two complete and separate triodes in one envelope. Each section of such tubes must be tested separately. The portion of the tube chart showing the settings for the 6SN7 is shown in Fig. 10-15.

Note that two groups of settings are given for this tube, and that they are joined by a bracket to call to your attention that this is a two-section tube. To test this tube, the settings are made first for the one section. The shorts test, quality test, and other applicable necessary tests are made for that section. Then the settings for the other section are made, and tests are repeated. Whenever more than one group of settings is given, all these tests must be made in order to check the tube.

TUBE TYPE	FIL.	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
6SN7	6.3	JX-4506-1	23	79	P4	2600	Triode No. 1
6SN7	6.3	JX-2103-5	23	79	P4	2600	Triode No. 2

Fig. 10-15

TUBE TYPE	FIL.	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
5U4	5.0	HR-0600-0	0	35	P3★	.....	Plate No. 1
5U4	5.0	HR-0400-0	0	30	P3★	.....	Plate No. 2

Fig. 10-16

Testing Rectifier Tubes. The portion of the test chart for a 5U4 rectifier tube is shown in Fig. 10-16.

For this tube, no figure is given in the MUTUAL CONDUCTANCE column. Notice the star (★) that is next to the pushbutton number in the PRESS column. This indicates that the mutual conductance of such tubes is not measured and that the quality of such tubes can be read only on the REPLACE-GOOD scale.

Certain tubes are good even though they may give a reading in the REPLACE section of the meter scale. An example of this type is the 1X2. The settings for this tube are shown in Fig. 10-17.

In the notations column is the remark "Cap=P. OK ABOVE DIODES OK." The meaning of this note is simply that this tube is good if the meter needle falls to the right of the DIODES O.K. mark on the meter scale. A close-up view of the meter scale where this mark may be seen is shown in Fig. 10-14.

The first part of this note shows that this tube requires that a connection be made to cap on the tube, as shown in Fig. 10-18. Such caps connect to the grid or plate of the tube. In this case, the cap on the tube is connected by the special lead provided to the jack on the tube test labelled P.

Testing Electron-Ray Tubes. An electron-ray or MAGIC EYE ® tube is a special form of tube used as a tuning indicator to indicate accurate tuning. This tube contains an elec-

TUBE TYPE	FIL.	SELECTORS	BIAS	ENG.	PRESS	MUT. COND.	NOTATIONS
1X2	1.1	BS-0000-0	0	80	P5★	.....	CAP-P. OK ABOVE DIODES OK.

Fig. 10-17

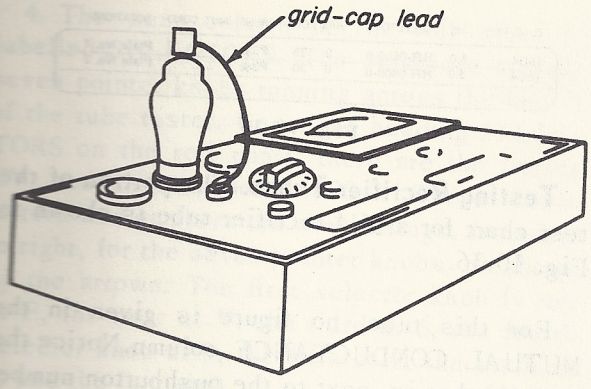


Fig. 10-18

trode coated with fluorescent material which glows when bombarded by electrons. In one popular type, a fan-shaped shadow appears on the fluorescent screen, and this shadow covers more or less of the screen as the receiver is tuned. The fan opens or closes, depending upon the tuning. Accurate tuning usually is indicated by maximum closing of the fan or eye, as it is called. The settings for the 6U5 type, which is a typical electron-ray or MAGIC EYE ® tube, are shown in Fig. 10-19.

The notations "Eye Open" and "Eye Closed" refer to the opening and closing of the fan-shaped shadow area. The eye should completely open at one setting and completely close at the other setting, as indicated in the chart.

Testing Cold-Cathode Rectifiers. Certain special tubes do not have a filament, but generate heat for the cathode in other ways. The settings for an OZ4, which is typical of this type, are shown in Fig. 10-20.

Notice first of all that this tube consists of two sections, so that two separate tests are required to completely check this tube. No filament voltage setting is given, which means that the filament knobs may be left at any point. The star after the push-button number indicates that the quality of this tube is shown on the REPLACE-GOOD scale.

TUBE TYPE	FIL.	SELECTORS	BIAS	ENG	PRESS	MUT. COND	NOTATIONS
6U5	6.3	JR-5403-0			P4		Eye Open
6U5	6.3	JR-5423-0			P4		Eye Closed

Fig. 10-19

TUBE TYPE	FIL.	SELECTORS	BIAS	ENG	PRESS	MUT. COND	NOTATIONS
OZ4		JR-0507-0	0	70	P2★		Plate No. 1
OZ4		JR-0307-0	0	70	P2★		Plate No. 2

Fig. 10-20

10-7. BUYING A TUBE TESTER

There are many makes and models to choose from, and many factors to consider when buying a tube tester.

One of the first things to consider is the ease of operation. Some tube checkers use push buttons, others use lever switches, while still others have rotary switches. You may find one type easier to use than others. One thing to consider is whether the roll chart is easy to read and operate.

Another thing to consider is the size of the tube checker. There are portable models, bench models, and counter models. The counter models have a very large meter so that they can easily be seen by customers. Which model is suitable for your needs? Consider also whether the scale is easy to read.

A third point to think about is the flexibility of the tester. Will it handle all present tubes and does it have provision for future tubes? Or can it be easily adapted to test new tubes as they come out? What provision has the manufacturer made to furnish you with information on new tubes? Are new roll charts supplied periodically to keep the tube tester up to date? Is the cost of these new charts reasonable?

And finally, will the instrument take a lot of use? Are replacement parts readily available? Does the manufacturer have repair facilities?

After you have obtained the answers to these questions, you will be in a good position to make your choice. In order to familiarize you with some of the tube testers sold today, photographs of several commercial service-type tube testers are shown in Fig. 10-21.

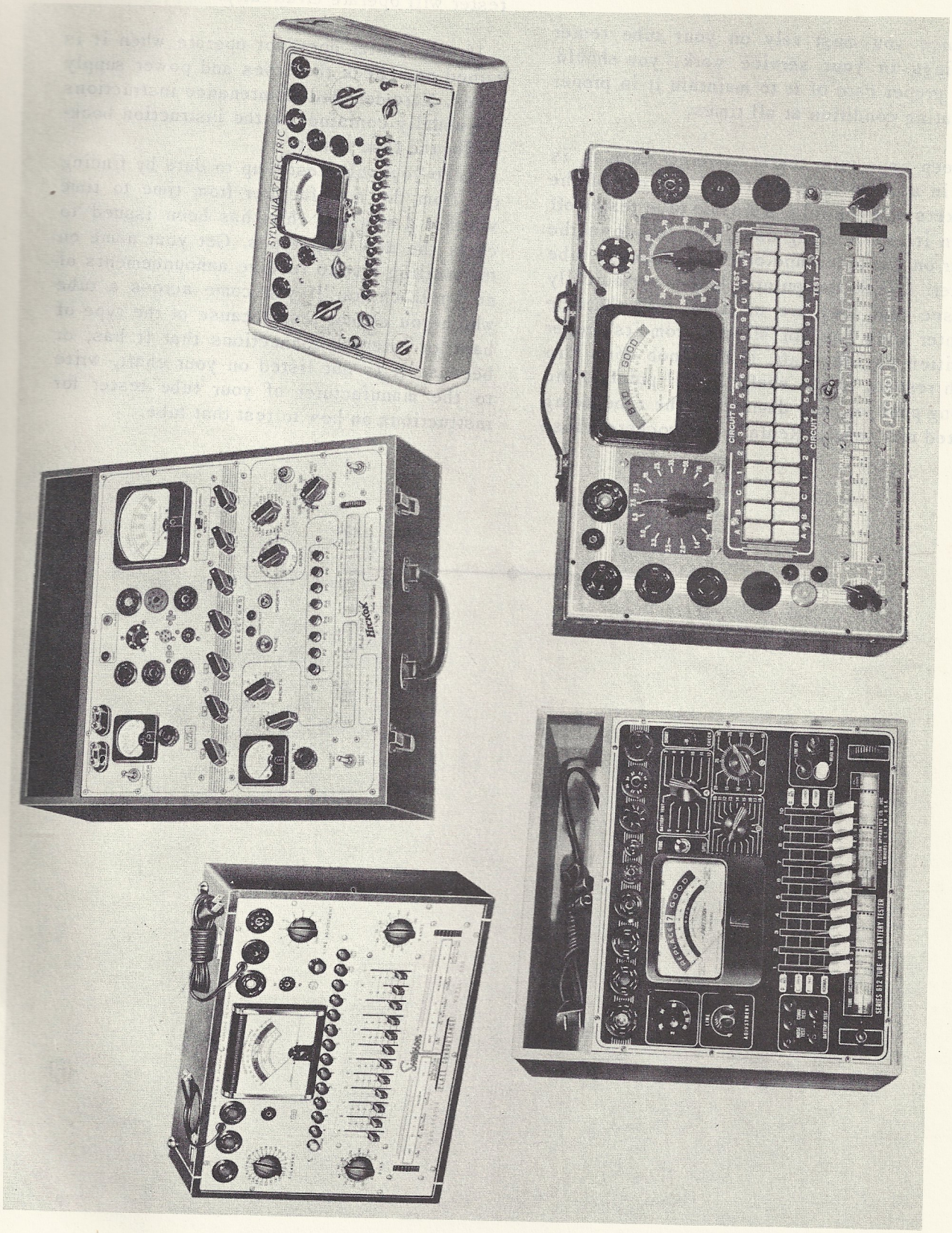

SYLVANIA ELECTRIC
CIRCUIT D
CIRCUIT E
TEST
GOOD
SERIES 512 TUBE AND BATTERY TESTER

Fig. 10-21

10-8. MAINTAINING YOUR TUBE CHECKER

Since you must rely on your tube tester readings in your service work, you should take proper care of it to maintain it in proper operating condition at all times.

Keep your tube tester covered when it is not in use, to keep dust and dirt out of the sockets and controls. Turn the tube tester off when it is not being used, to keep down the wear on the tubes and other parts in the tube tester. Check the pointer knobs periodically to see that they are on tight and that the pointer knob has not slipped from its proper position on the shaft. If the knob does slip with respect to the shaft, it will point to the wrong position, and damage to the tube being tested may result. Replace any sockets whose pin contacts loosen up; otherwise your tube tester will operate erratically.

If your tester does not operate when it is turned on, check the fuses and power supply tubes. More-detailed maintenance instructions are usually contained in the instruction booklet for the tube tester.

Keep your tube tester up to date by finding out from the manufacturer from time to time, whether a new roll chart has been issued to cover the new tube types. Get your name on the mailing list to receive announcements of new roll charts. If you come across a tube which you cannot test because of the type of base or internal connections that it has, or because it is not listed on your chart, write to the manufacturer of your tube tester for instructions on how to test that tube.