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**Message from the President:**

**This booklet was prepared for you--the owner of television sets, radios and other home entertainment electronic devices.**

**If you've never checked and replaced a faulty tube in your television set and had the self-satisfaction of watching that favorite program you thought you were going to miss, then this booklet will give you confidence by showing you how easy it can be. If you've tried self-service before and had problems, then the helpful information and directions in this booklet will help you eliminate those problems. Even if you've been quite successful in servicing your own electronic devices, we believe this booklet will be a useful guide to better results.**

**U-Test-M, Inc., America's pioneer name in self-service tube testers wishes you successful troubleshooting, and viewing and listening pleasure.**

3  
TV  
Repair

# U-TEST-M TV AND RADIO TROUBLESHOOTER'S GUIDE

This booklet shows you—in practical, down-to-earth terms—what goes wrong in TV sets, radios, phonographs, car radios, and FM and stereo sets. It shows you how to check and replace faulty tubes—and they are what cause more than half the troubles in radio and TV sets. This booklet also tells you how to solve other problems that don't involve tubes. You don't need electronics training to follow these simple, specific directions. If you are a reasonably good handyman, the instructions are easy.

Glance through the pages of this booklet right now. Find out what it contains—see for yourself how you go about pinning down faults in radio and TV sets. Then later, when you want to fix your TV, read the TV section carefully. When you want to fix your radio, read that section. And so on. Learn what troubles to look for in each kind of set.

After you've used this booklet once or twice, you'll be amazed at how quickly you've picked up TV self-service know-how. The same is true for radios and phonographs. The more you work on them, the easier it becomes. So go ahead—and save yourself money.

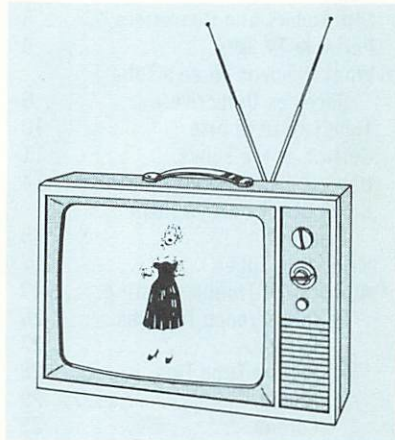
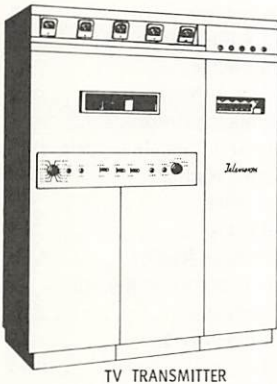
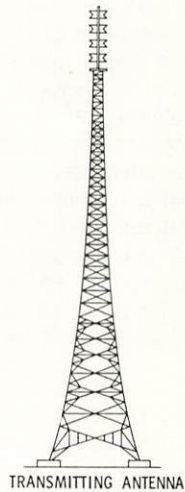
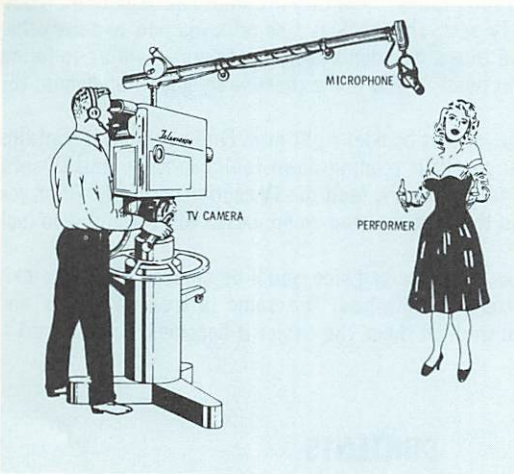
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## TV—From Station to You

To do an intelligent job of figuring out the cause of TV troubles, you need to understand the way a TV set works. Here's a brief rundown of how a television program makes its way from the station to your living room.

It all begins in the TV studio. A TV **camera** picks up light waves from a scene, much as your eye does. At the same time, a **microphone** picks up sound waves of the performers' voices. The camera and microphone convert the light and sound waves into electrical **signals**. These signals are then changed into TV waves by the transmitter and radiated, or broadcast, from the station's **antenna**.





At your home, the TV **antenna** picks up the TV waves and feeds them into your TV set. The set converts the waves back into picture and sound signals. The picture signals make a picture on the screen of the **picture tube**. The sound signals are fed to the **loudspeaker**, which then reproduces the performers' voices.

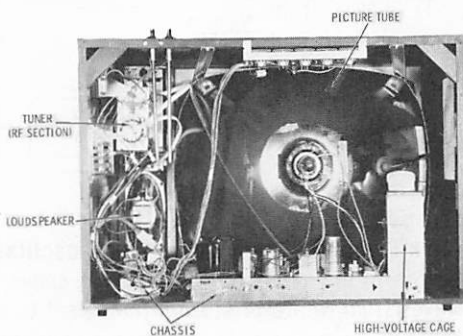
A TV station must be transmitting properly before you can see a good picture or hear good sound on your TV set. Sometimes, you may think your set is at fault when it's really station trouble. Check by switching to another channel.

Also, your TV antenna must receive a clear signal. Indoor rabbit-ear antennas can't pick up good picture and sound at every location. If you've moved recently, or are vacationing at some new location, you may find your portable TV doesn't work well with its built-in antenna. Ask a neighbor how his picture is. Maybe one channel is harder to get than others. Don't blame your set until you've checked reception on other sets in the area.

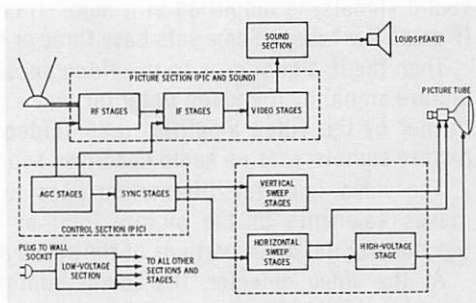
### How a TV Set Works

Inside the cabinet of your TV set is the **chassis**—just as the chassis of a car is inside the body. Nearly all the **componets**, or parts of the set, are mounted on the chassis. The parts are wired together to form **stages**, which in turn are grouped into **sections**. The picture tube may be mounted separately, fastened to the front of the cabinet; usually, too, the loudspeaker is hidden in some out-of-the-way place, but it's always facing outward on the side or front of the cabinet. Look at the position of the **tuner (RF section)** and the **high-voltage** cage; you'll need to find them later.

This is a **block diagram** of a typical black-and-white TV set. A block diagram shows you the different stages and sections of a TV set, labeled by what they do,



BACK OF SET WITH COVER REMOVED



and grouped according to whether they affect picture or sound. To find trouble in your TV set, you must first figure out which section is at fault. A block diagram helps.

There are three major sections. The **picture section** contains the stages that make the picture light and dark, clean and sharp, or fuzzy and snowy. The picture section can also have side effects on other sections, such as sound.

The **control section** has stages that hold the picture steady and prevent fading.

The **sweep section** "paints" the picture on the screen, by sweeping a beam of light back and forth on the picture-tube face.

The **sound section** operates the loudspeaker, just like in a radio.

The **low-voltage section** (sometimes called power supply) furnishes special electric power to operate all the other sections and stages in the TV set.

### Picture Section

The picture section is subdivided into three smaller groups of stages. Each stage contains one or more tubes. These smaller groupings are the **RF stages**, the **IF stages**, and the **video stages**.

TV waves from your TV antenna go first to the **RF stages**, which are called the **tuner**. The **RF amplifier tube** amplifies, or strengthens the

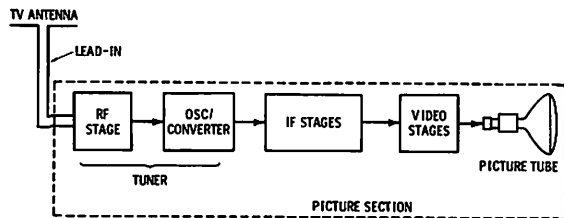
weak TV waves. Next, the **converter/oscillator tube** makes it possible to switch to any channel you wish. The converter changes the incoming TV waves from whatever station you select to a special signal (called an IF) that can be more easily amplified and processed by later stages.

In the **IF stages**, the IF signal (which still contains the picture and sound signals) is amplified still more. This is done by the **1st and 2nd IF amplifier tubes**. (Some sets have three or even four IF amplifier tubes.)

Then the IF signal goes to the **video section**, where it is changed to a picture signal by the **video detector** (not a tube) and then strengthened further by the **video amplifier tube**. (**Video** is a word used to describe picture signals, just as **audio** describes sound signals.)

The video (picture) information goes to the picture tube, where it makes segments of the picture light or dark, corresponding to the lightness or darkness portions of the scene at the TV studio.

At the video detector, the sound information is taken from the IF signal and fed to the sound section.



Finally, the **sync** (short for **synchronizing**) information is separated from the other signals, and fed to the control section.

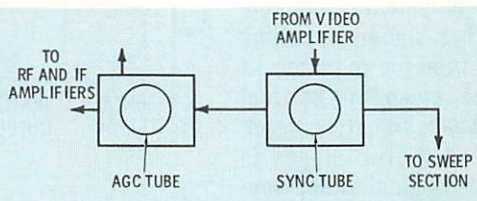
Other stages and sections in the TV set depend on the stages in the picture section to carry the signals they must process. Thus if anything goes wrong in the picture section, it affects other parts of the TV set.

### Control Section

There are usually two, sometimes three, tubes in the control section. Sometimes a single dual-function tube is used. (Dual-function tubes are used in other sections, too.) The first job of the control section, the job performed by the **sync** or **sync-separator** tube, is to pass synchronizing information to the sweep section, while keeping out sound or picture signals. Without proper sync information, the picture may roll up or down, or wobble from side to side. Sometimes a picture without sync twists into an unrecognizable mess.

The sync tube also passes a signal to the **AGC tube**. (AGC stands for "automatic gain control.") The AGC stage controls **how much** the RF and IF amplifiers

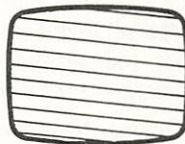
strengthen the TV wave. Some stations you watch are near and powerful, and your TV set receives strong signals; others are far away or weak, and so the TV signals your set receives are weak. In a properly operating TV set, the AGC tube adjusts the RF and IF tubes so that they amplify weak signals more than strong signals, and you get a clear, bright, even picture on all channels.



### Sweep Section

The TV picture is made by "painting" it on the picture-tube screen with a spot of light—line by line, as shown in the diagram. Only ten solid lines are shown here, but a TV picture contains about fifty times that number. You can see them if you inspect the TV screen closely while the set is turned on.

As the spot of light moves across the screen along each of these lines, its lightness or darkness is varied by the video signal from the video amplifier tube. Why can't you see the moving spot instead of what looks like solid lines? Because it moves too fast. How come you can see a complete picture? Because the **phosphor** coating of the picture-tube screen stays lit long enough for your eye to take in the entire scene.

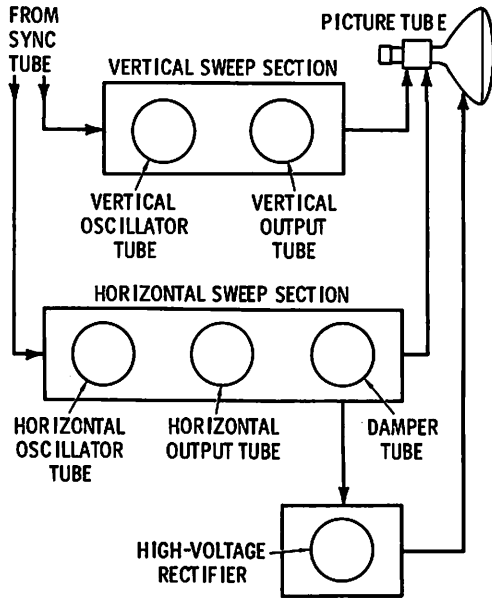


The **horizontal sweep** stages are what moves the spot of light from

side to side, making each line you see. The **horizontal oscillator tube** originates the sweep signal that moves the spot (or beam). The oscillator's signal is amplified by the **horizontal output tube**. Plenty of energy is required to move the spot from side to side, though. So a third tube—the **dampener**—helps furnish the extra energy. The horizontal signal is then fed to a coil of wire on the neck of the picture tube; from there, it sweeps the spot of light from left to right across the screen.

While the spot, or beam, is being swept from side to side, another signal is pulling it from top to bottom of the screen. This **vertical sweep** signal is developed by two stages in the **vertical sweep section**. Both stages are often inside one tube. The **vertical oscillator**

generates the sweeping energy, which is amplified by the **vertical output tube**. This signal is fed to another coil on the neck of the picture tube; from there it sweeps the spot of light up and down the screen.



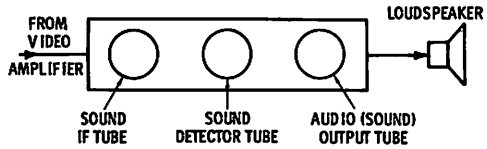
The TV camera also has vertical and horizontal sweep signals, and your TV set must keep in exact step with them. That's what sync (or synchronizing) information is for. Sync signals are transmitted (by the TV station) right along with the video signals. These sync signals, as you can see from the block diagram on page 3, are recovered in the video section. From there, they are fed to the sweep stages, where they keep the vertical and horizontal oscillators precisely in step with the camera at the TV station.

Inside the picture tube, the beam is pulled to the screen from back in the neck by high voltage (as much as 20,000 volts in some sets). The high voltage is applied at a "button" on the back (bell) of the picture tube, near the screen. The horizontal sweep section produces such a lot of energy, some of it is "borrowed" and fed to the high-voltage section. There, a **high-voltage rectifier tube** changes the high-energy signal from the horizontal section into the high DC voltage that's needed by the picture tube.



## Sound Section

In the sound section, there are usually two or three tubes. The **sound IF tube** amplifies the weak sound IF signal taken from the video amplifier. The **sound detector tube** (sometimes called **audio detector**) converts the sound IF signal into audio signals. Finally, the **audio output tube** amplifies these audio signals. Then they are fed into the loudspeaker. The loudspeaker creates sound waves which reproduce the performers' voices.

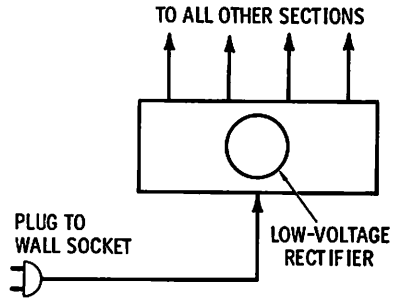


## Low-Voltage Section

Every section and stage in a TV set needs special electric power called DC (direct current). The electric power that comes from the wall socket is AC (alternating current). For the TV set, the AC must be converted to DC—and the job is done by the **low-voltage rectifier**. If the low-voltage rectifier tube is not working properly, no other section of the TV set can operate.

Today, many sets don't use a tube as the low-voltage rectifier. Instead, they use a **semiconductor diode**. (You'll learn more about diodes later.)

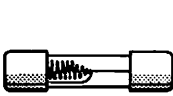
Some portable transistor TV's operate from batteries instead of from the wall socket. Since batteries always supply DC power, such sets don't need a low-voltage rectifier.



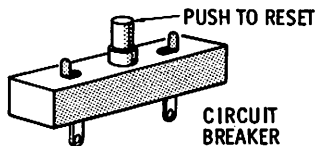
## Fuses and Circuit Breakers

The wiring in your house is protected against short circuits by fuses or circuit breakers. If a short occurs, the fuse disconnects voltage from the circuit before the wiring can overheat and cause a fire. Then you or your electrician must clear up the short and replace the fuse or reset the breaker.

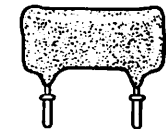
Fuses and circuit breakers are also used in TV sets, to protect them against short circuits. Three protective devices are shown here. The fuse and the fusible resistor must be replaced whenever they "blow" or open



TV FUSE



CIRCUIT BREAKER



FUSIBLE RESISTOR

up. The circuit breaker, however, can be reset by pushing in its small pushbutton.

If a fuse blows or a circuit breaker trips, the TV set loses all power. Therefore, when the set has no picture and no sound, you should check the fuse or circuit breaker first.

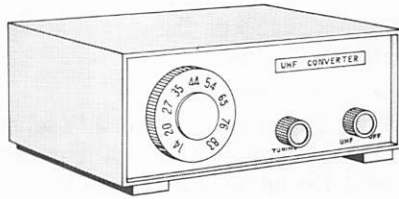
## UHF Tuners and Converters

When TV stations first came on the air in the 1940's, they used only VHF (very-high-frequency) channels (2 through 13). All TV sets can receive the VHF channels.

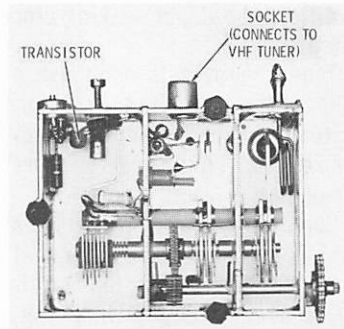
In the 1950's, other TV stations came on the air using new UHF (ultra-high-frequency) channels (14 through 83). Since 1964, practically all TV sets sold in this country can receive both VHF and UHF channels. For older sets that tune only VHF, **converters** are available which change UHF to VHF. Converters let owners of older sets tune in the newer stations.

A UHF converter is about the size of a table-model radio (see the illustration). A UHF antenna is connected to the converter, and the output of the converter is connected to the antenna input terminals of the TV set. Some UHF converters use tubes, which you can test just the same as other TV tubes.

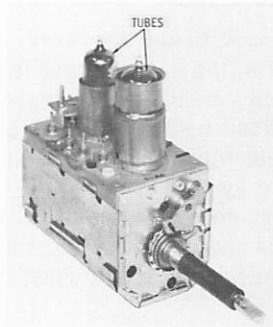
Modern TV sets have two tuners inside—one for VHF, the other for UHF. The UHF tuner is often mounted on the VHF tuner, and the VHF fine-tuning knob doubles as tuning knob for the UHF tuner. In some sets, the signal from the UHF must pass through the VHF tuner. If the latter type isn't working properly, you cannot tune in UHF channels or VHF



UHF CONVERTER



RF TUNER ASSEMBLY



UHF TUNER

channels. Nearly all modern UHF tuners use transistors, and must be serviced by professional technicians. A few older UHF tuners and almost all VHF tuners use tubes, which you can test yourself, like any other TV tube.

### Portable TV Sets

You can fix portable TV sets just as you can console models. The only difference is that portable sets are compact, and all the parts are squeezed into a smaller space. Instead of a single chassis on the cabinet bottom, portables have two or three separate chassis mounted on the bottom and sides of the cabinet. Because you have to work in a limited space, tubes are a little harder to get out of and back into sockets in portable sets.

### What Happens When a Tube Becomes Defective

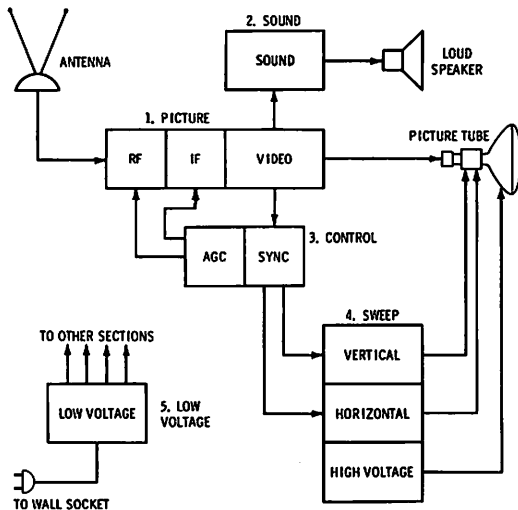
The television part that's easiest to replace is the tube. Almost all other components are soldered into their circuits, which makes them hard to test and hard to replace. Tubes, on the other hand, are plugged conveniently into sockets. To test one, you have only to pull it out of its socket and take it to a tube tester. Replacing a tube is merely a matter of plugging a new one into the proper socket. That's the repair you are most likely to make in any faulty TV set. So...what can happen to tubes?

Generally, when a tube is weak, it still operates but doesn't do its job very well. When a tube is dead, it usually doesn't work at all. A tube that short-circuits internally may blow the fuse or even cause other, more serious trouble.

This is a simplified version of the block diagram you saw earlier. Study it. Remember that each section does a specific job (or jobs). If a tube goes bad in one section, it usually affects only that job. Here are some examples.

1. A weak tube in the picture section usually causes the picture to look washed-out or snowy.

The sound may become weak, fuzzy, or distorted, since sound signals must pass through part of the picture section. For the same reason, sync



signals may also become weak, and whatever picture there is may be hard to hold in place on the screen. A **dead** tube in the picture section usually blocks the picture altogether. The sound may be gone, or possibly just weak. But the screen stays bright, because sweep and high-voltage sections are not affected.

2. Weak or dead tubes in the sound stages usually affect only the sound, which may become weak or distorted, or may be eliminated entirely.

3. In the control section, a weak or dead AGC tube can cause washed-out pictures on some channels, and very black, harsh pictures on others. A weak or dead sync tube causes the picture to roll vertically or to wobble left and right. As long as you can move the picture one way or the other with the horizontal and vertical hold controls, you can be fairly sure the sweep section is all right and the trouble is in the sync section.

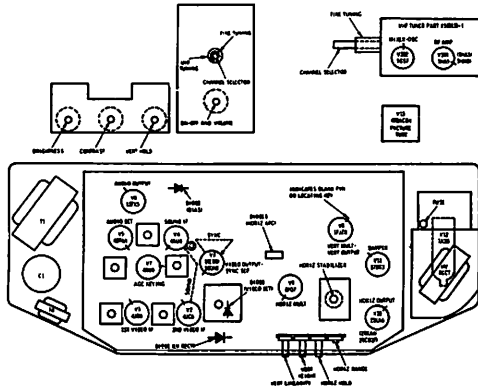
4. When objects or people in the picture look squatty or stretched, one of the sweep tubes is probably at fault. Weak or dead **vertical** sweep tubes usually affect only the up-and-down size of the picture.

However, high voltage is derived from the **horizontal** sweep stages, and a weak or dead horizontal tube usually kills high voltage. That means there can not be a spot of light to be swept back and forth, and therefore no lines. In other words, the screen doesn't light up at all. A bad high-voltage rectifier tube can also kill high voltage.

5. A weak low-voltage rectifier affects the operation of all the other sections. The picture shrinks and sometimes becomes washed out. Sound is often distorted and it may be difficult to keep the picture straight or synchronized. A completely dead low-voltage rectifier usually kills both picture and sound, and there is no brightness on the screen. The clue to this fault is that other tubes are usually lit. (An open circuit breaker can cause this symptom. Try resetting it first.)

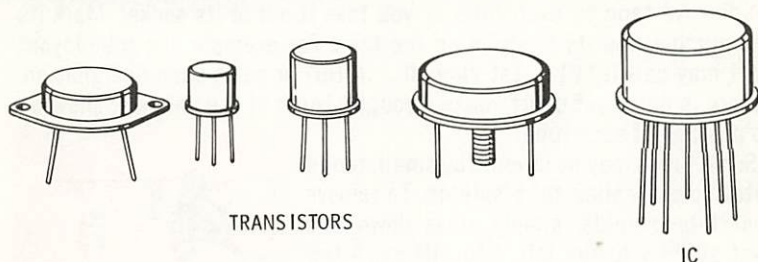
## Tube-Layout Charts

Most TV sets have tube-layout charts pasted on the back of the set or inside the cabinet. A sample is shown in the diagram. The tube function is listed (1st Video IF, for example), and the tube type (4JD6). The mark on the circle represents the keyway in the center of the circle of pins (on certain tubes), or the wide space between pins. You must match the keyway or the wide space of each tube to



its socket; otherwise, the tube won't fit.

Many TV sets and radios now use semiconductor (called solid-state) diodes, transistors, and IC's (integrated circuits). A few of these devices are shown below. They are often used instead of tubes—especially in



small portable TV's. Diodes, transistors, and IC's are generally wired into the circuit and cannot be easily replaced. If you have trouble in a solid-state set, take it to your local service technician. Fortunately, transistors are generally more reliable than tubes, and you probably won't have trouble quite as often.

### Getting At The Tubes

Before you test tubes, make a visual inspection inside the set. Take the screws out of the top edge of the back cover, and one or two down the sides. Pull the cover open so you can see the tubes with the set turned on. **DON'T TOUCH ANYTHING INSIDE, YET.** Look for tubes that aren't lit, or that spark or flash internally. Notice the location of such tubes—you'll want to test them first.

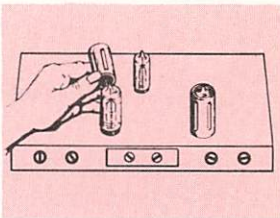
Tubes can be weak or shorted, even when they are lit and appear normal. The way to find out is to test them. **PULL THE PLUG FROM THE WALL SOCKET** before you work inside the cabinet. Be careful about disconnecting the **interlock**, which unplugs the chassis from the power cord. The interlock is for your protection; it makes sure you won't get shocked while touching parts inside the cabinet. Never cheat the interlock by connecting a jumper cord, unless you know where all the dangerous voltages are.





When you remove a tube to test it, be sure you get it back in the same socket. Sometimes two or more tubes of the same type-number are used in a set; but if you swap them around, the set won't work properly. If there's any chance of getting tubes into the wrong sockets, put a piece of adhesive tape on each tube as you take it out of its socket. Mark its type number and its function on the tape. For example, the tube layout chart may call it "V1. . .1st Video IF. . .4JD6" or some such designation. If there is no layout chart, make a rough sketch of the chassis, showing the position of each tube.

Some tubes may be covered by small, round metal covers called **tube shields**. To remove most tube shields, simply press down and twist slightly to the left, then lift up. A few shields just fit tightly around the tube — they come off along with the tube. A type used only occasionally telescopes downward; slide the top half of the shield downward and the tube is exposed so you can grip it.



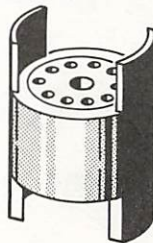
Tubes in a TV set that's been turned on are **HOT!** Let them cool off, before you reach in to touch them.

To pull a tube out of its socket, rock it gently from side to side, pulling upward in a circular motion at the same time. Take your time, handle each tube with care (remember they're glass), and you will have no difficulty getting them out to test.

Although you should let the tubes cool off some before removing them, they should feel warm as you handle them. If you find a **cold** tube, in a set that has been on, chances are it's defective. Make sure it's one you test.

If you find it hard to read the type numbers on some tubes, let them cool and then breathe on them gently. The moisture in your breath will condense on the glass surface and the numbers (4JD6, 8FQ7, etc.) will stand out so you can see them.

When testing and replacing tubes, you may find an 8-pin tube with its aligning post broken off at the base. (That's the black plastic post in the center of the circle of pins.) Throw such a tube away; it's too easy to put it in the socket incorrectly, and cause serious and expensive damage to the set.

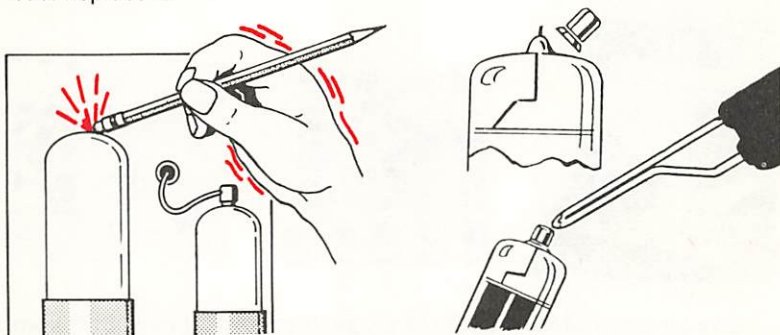


TV-tube pins are small and sometimes easily bent as you pull a tube out of its socket or try to put it back. Use a pin straightener (available at most tube-tester locations) to keep miniature tube pins straight and uniform. It will preserve the life of both tubes and sockets.

Occasionally you'll find a tube with a crack or with its glass bulb separated from its base. It may also have a "milky" look inside the glass bulb. Such a tube has lost its vacuum and can't work properly. Replace it.

Some tubes **arc** internally—make sparks and sometimes frying noises. You see this chiefly in damper tubes like 6AU4, 6DW4, 6CL4, and others. These tubes are near the high-voltage compartment, which is a metal box on the chassis (sometimes with holes or slots in it).

You can check for internal arcing or flashing by tapping the tube with the set turned on. **BE VERY CAREFUL.** Keep the interlock connection intact, and pull the top of the cabinet back outward slightly. Put the plug in the wall socket. Use a wooden pencil, preferably with an eraser, to tap the suspected tube. The tube normally glows a dull red; if you see white flashes in the tube or on the picture-tube screen as you tap the tube, it's bad. Replace it.



Two tubes in most TV sets (three in some color sets) use a **top-cap connection**. These are the horizontal output tube, the high-voltage rectifier tube, and—in some color sets—the high-voltage regulator tube. (The latter two are **inside** the high-voltage cage.) The top cap sometimes becomes loose or comes off altogether. It may stick inside the clip that attaches the lead-wire to it. The best fix is to replace the tube.

If the tubes in a set light up, there are two general ways to test them. One is to remove them from the set and test them in a tube tester. However, this does not always show up defective tubes that must operate in a critical circuit. Another method is to replace a suspected tube with a new one, right in the set. Sometimes this is the only way to get a true test of how a tube is working (or not working).

If the tubes don't light up, and they are in a "series-string" set, you can use a neon-lamp tester to check their filaments. Pages 15 and 16 tells how.



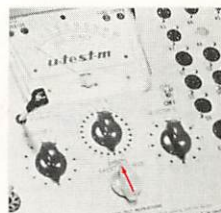
## Using a Self-Service Tube Tester

Most tube testers provide at least two checks of tube operation. The **Shorts Test** tells you if a tube is short-circuited (has elements inside touching each other); of course, such a tube can't work properly in a set. Even if a tube isn't shorted, it still must amplify or otherwise process the signals it's supposed to—and the **Emission Test** tells you whether it can or not.

Tube testers vary. Some have only a few sockets, and therefore several switches to set up for each tube. Others have many sockets and few or no switches. Whatever the kind of tester you use, read the instructions on its panel or chart carefully. Set up any switches or knobs that are required **BEFORE** you put a tube into any socket.

Then carefully insert the tube in the socket called for. If the tube has a metal cap or post on top, be sure to clip the wire from the testing panel onto it. If the wire isn't clipped on, you won't get a correct test reading.

Never try to test more than one tube at a time; you'll get a false reading.



Make the Shorts Test first. If there's an internal short circuit between tube elements, the tube can't possibly work right. Sometimes a gassy tube will test as if it's shorted. The inside of a TV tube should be a vacuum, and if gas is present, the tube is bad. Replace it.

If a tube passes the Shorts Test, check it for Emission. The number the meter pointer indicates should be equal to or more than the number given on the tube tester chart. For example, a 12AU7 should read 70 or better on the U-Test-M tester. If you get a lower reading, the tube is weak and should be replaced.

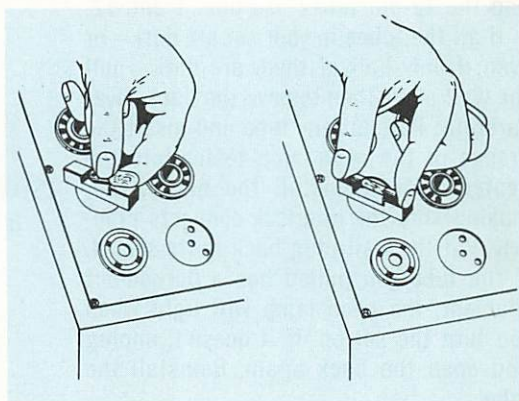
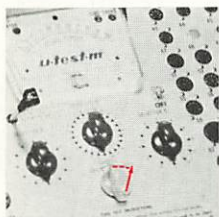
Some tubes work okay even though they test 5 or 10 points below the recommended value. The operation of other tubes, however, is more critical. Tubes used as **converter**, **horizontal oscillator**, and **horizontal output** stages must be right up to par. If one of these tubes reads as little as 5 points below the recommended value, it may not do its job.

While a TV set will sometimes work with weak tubes, it can't work well. Furthermore, weak tubes only get weaker, and soon your set won't

operate at all. In a few cases, weak tubes may do outright damage as they get worse. It's probably worth your time and money to go ahead and replace weak tubes while you're at it, rather than try to get by with them.

Your set may have an **intermittent** tube—one that works right only part of the time. An intermittent tube may test good in a tester because you only check it for a minute or two. But when you put it back in the set, sooner or later back comes the trouble. When you first test a tube for Shorts, always tap it with a pencil or some other light object, while it's in the tester. As you tap it, watch the tester's Short light for any sudden reaction. Do the same as you test Emission, and watch the meter for pointer fluctuations. Another way to find an intermittent tube is to substitute a new tube for it and run the set awhile.

You can test pilot lamps in a U-Test-M tube tester. Place the center contact of the lamp base against one tester contact. Touch the metal lamp shell to the other tester contact. If the pilot lamp lights, it's good. If the lamp doesn't light, it's defective. (Don't do this with flashlight bulbs; it might burn out a good one.)



To test a fuse or fusible resistor, place it across the labeled contacts on the tester and watch the indicator light. On the U-Test-M tester, this is the left Vibrator light. If the lamp lights, the fuse is good; otherwise it's defective.

### Quick Checks With a Neon Tester

You can troubleshoot one common tube fault in TV and radio sets with an inexpensive **neon tester**.



The tube heater (the element that glows when you turn the set on) in many TV and radio sets are wired together in a **series-string** arrangement, like old-fashioned Christmas-tree lamps. If the filament of one



tube burns out, none of the tubes can heat up. What you have to do is find the one tube with a burned-out filament and replace it, and you've fixed the set.

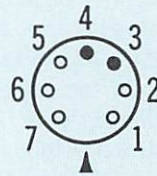
The diagrams on this page show you four types of sockets used for nearly all tubes in radio and TV sets. The socket holes are shown as you see them after you've pulled out the tubes. In each diagram, the larger black holes indicate the socket pins to which the voltage for the heaters is connected beneath the socket.

The black triangle indicates the keyway or the wide space that orients the tube in its socket. The wide space is always situated between pin 1 and the highest-numbered pin. You count pins counterclockwise from the keyway. Most 8-pin tubes use pins 2 and 7 for heater connections. A few older types, however, use pins 7 and 8. The 7-pin tubes use pins 3 and 4, the 9-pin tubes use pins 4 and 5, and the 12-pin tubes use pins 1 and 12.

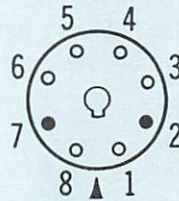
If all the tubes in your set are dark—or even if only half of them are dark—pull the wall plug. Then remove the back cover carefully. Pull out any tube and insert the prongs of the neon-lamp tester into the heater holes in the socket. Reinstall the back cover, making sure the interlock connects properly. Put the wall plug back in its socket. If the tube you pulled has a burned-out filament, the neon lamp will light when you turn the set on. If it doesn't, unplug and open the back again. Reinstall the tube.

Try the same thing with another tube. Pull the tube out and plug the neon tester into the heater holes in the socket. Always keep the set unplugged and turned off while you pull the tube and insert the neon tester. Then plug it in and turn it on to make the test.

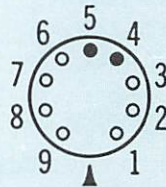
During the test, be sure ALL tubes are in their sockets except the one where you're testing. When you find a socket in which the neon lamp lights, it means all the other heaters are okay and the faulty one is the one you have out of the socket.



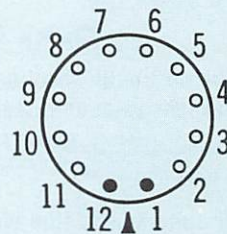
7-PIN TUBE



8-PIN TUBE  
(SOME USE PINS 7 AND 8 FOR FILAMENTS)



9-PIN TUBE



12-PIN TUBE



## Replacing Tubes

After you've checked the tubes and purchased any new ones you need, be sure you replace them all in the right sockets. Consult the tube-layout diagram that's pasted in the set, or the one you made as you took tubes out of the set. A tube in the wrong socket can seriously damage your set — and perhaps the tube, too.

Be sure you put each tube in its socket correctly. If your set has some 8-pin sockets, the tubes for them have an **aligning key** on their plastic center post. Fit the aligning post into the center hole of the socket and rotate the tube until you feel it slip down slightly. Work the pins into the socket holes gently. If you use too much pressure you'll bend the pins. You may also break the tube and risk cutting yourself.

The bases of 7-, 9-, and 12-pin tubes don't have aligning keys. Instead, they have a wide space between one pair of pins. Look at the socket until you see the wide space between holes; then install the tube **CAREFULLY** that way.

If you don't get the tube pins aligned precisely, with the wide space between the pins exactly in line with the wide space between the socket holes, you can damage the tube pins. At the least, you may bend them out of shape and make it difficult to insert the tube properly at all. At worst, a bent pin can crack the tube glass and let air in, ruining the tube. You'd have to buy a new one.

Some chassis corners are dark, and the sockets are hard to see. A small flashlight or penlight is a big help. Once you look at the socket and remember which way the keyway space is oriented, you can guide the tube in by feeling the space in the pins with a finger. Never push hard. You don't want bent tube pins.

When the tubes are in place, make sure you haven't accidentally pulled any wires loose. Also be sure that all wires to top-cap tubes are connected and that all tube shields are back in position.

Next, replace the back cover. Be sure the interlock makes good contact. If you had to remove antenna connections to get the back off, put them back the way they were. Be sure there are no wires shorting across the antenna connection screws.

You should now be able to turn on the set and get a clear picture and sound. Remember, though, replacing tubes sometimes changes picture height and width (or other adjustments) slightly. You may have to reset some controls.

Keep a written record of tubes you've replaced and adjustments you've made. If one tube fails repeatedly, a resistor or capacitor or some wrong adjustment is causing it. For that, call your local service technician. Show him your notes; they will help him give you faster (and less expensive) service.

## Tube Substitution

It is usually better to get an exact replacement for a bad tube, but sometimes you can't find one. In certain cases, another tube type will do as well—maybe even better. For example, the 6CU6 is an improved version of the 6BQ6, and will do a better job.

Here is a list of tubes that are common in modern TV sets, and substitutes for them. This list includes only the basic tube designation—for example, 6BQ6. Actually, there are several versions of this tube—6BQ6G, 6BQ6GA, 6BQ6GT, 6BQ6GTA, and 6BQ6GTB. All are similar, but the further along the list you go, the more improved the tube is.

Tube in Question	Substitutes	Tube in Question	Substitutes
1B3	1AU3, 1G3, 1J3, 1K3, 1N2	6BC8	6BQ7, 6BS8, 6BX8, 6BZ7, 6BZ8, 6HK8, X155
2AV2	2BA2	6BE6	6BY6, 6CS6
2CW4	2DS4	6BJ3	6AX3
2GK5	2FQ5	6BL7	6BX7, 6DN7
3A3	3CA3	6BL8	6EA8, 6U8, 6LN8
3AT2	3BN2	6BQ5	7189
3AU6	3BA6	6BQ6	6CU6, 6DQ6, 6FH6, 6GW6
3AW3	3A3, 3CA3	6BR8	6FV8, 6JN8
3CB6	3CF6, 3DK6	6BU8	6GS8, 6HS8, 6KF8
3EH7	3EJ7	6BZ6	6DC6, 6HQ6, 6JH6
3GK5	3FQ6	6CB5	6CL5
3HA5	3HK5, 3HM5, 3HQ5	6CB6	6AW6, 6CF6, 6DC6, 6DE6, 6DK6, 6HQ6
3HM6	3HT6, 3JC6, 3JD6, 3KT6	6CD6	6DN6, 6EX6
4AU6	4BA6	6CG3	6CD3
4BL8	5EA8, 5U8	6CG8	6FG7
4BQ7	4BC8, 4BS8, 4BX8, 4BZ7, 4BZ8, 5BK7	6CW4	6DS4
4BZ6	4JH6	6CX8	6EB8, 6GN8, 6HF8, 6JA8, 6JE8
4CB6	4CF6, 4DE6, 4DK6	6DE4	6CQ4
4CS6	4BE6	6DE7	6EW7
4EH7	4EJ7	6DR7	6FD7, 6FR7
4HA5	4HK5, 4HM5, 4HQ5	6EH7	6EJ7
4HM6	4HT6, 4JC6, 4JD6, 4KT6	6EM7	6EA7, 6GL7
4HS8	4BU8, 4GS8, 4KF8	6ES8	6DJ8
5BR8	5FV8	6EW6	6GM6
5CG8	5FG7	6GH8	6EA8, 6U8
5DJ4	5DN4	6GJ7	6GX7
5EA8	5U8	6GK5	6FQ5
5EW6	5GM6	6GY6	6GX6, 6HZ6
5GH8	5EA8, 5U8	6HA5	6HK5, 6HM5, 6HQ5
5U4	5AR4, 5AS4, 5AU4, 5DB4, 5R4, 5T4, 5V3	6HL8	6BL8
6AF3	6BR3	6JC6	6HM6, 6HT6, 6JD6, 6KT6
6AF11	6AS11, 6BD11	6JS6	6KD6
6AL5	6EB5	6JT8	6JA8, 6KR8, 6KV8, 6LB8, 6LQ8, 6LY8
6AM8	6HJ8	6JV8	6AW8, 6KS8, 6LF8
6AQ5	6HG5	6KD8	6EA8, 6GH8, 6U8
6AU6	6BA6, 7543	8AW8	8AU8, 8BA8, 8BH8, 8KS8, 8JV8
6AU8	6AW8, 6BA8, 6BH8	8EB8	8CX8, 8GN8, 8JE8
6AV6	6AT6, 6BK6, 6BT6	10E7	10EW7
6AX4	6AS4, 6DA4, 6DM4, 6DQ4, 6DT4	10EG7	10EM7
6AY3	6BA3, 6BS3, 6CK3, 6CL3, 6DW4	10HF8	10EB8, 10GN8, 11JE8, 10LZ8, 10JY8, 10JA8

Tube in Question	Substitutes	Tube in Question	Substitutes
11KV8	10JT8, 10KR8, 10LW8, 10LB8, 11LQ8	13DR7	13FD7, 13FR7
12AF3	12BR3	13EM7	15EA7
12AX4	12D4, 12DM4, 12DQ4	15BD11	15AF11
12AX7	12DF7, 12DT7, 7025	17AX4	17D4, 17DM4, 17DQ4
12BQ6	12CU6, 12DQ6, 12GW6	17AY3	17BS3, 17CK3, 17CL3, 17DW4
12BY7	12BV7, 12DQ7	17CU5	17C5, 17R5
12C5	12CU5, 12R5	17DE4	17CQ4
12CA5	12EH5	17DQ6	17GW6
12FX5	12ED5	19AU4	17CQ4, 17DE4
13DE7	15EW7	22JF6	22KM6
		38HE7	38HK7

## ABC'S OF TV TROUBLESHOOTING

A service technician looks at the picture and listens to the sound to diagnose the trouble in a TV set. You can do it, too, and fix many of these troubles yourself. Remember that some tubes affect only the picture, some only the sound, and some both.

On the following pages are illustrations of common faults in TV sets. Look for the picture that shows the symptoms that appear on your own set. Then refer to the remedy indicated by the letter or letters below the picture. Follow the simple instructions given by those letters in the following list. Read **all** the instructions indicated beside any symptom; some symptoms have several possible cures.

On these pages are also sample chassis and tube layouts of modern TV sets. They give you an idea how your own set looks.

- A Check the antenna connections on the back of the set (and those wires inside that go from the terminal board to the tuner). The wires should be tightly connected to the antenna screws, but there should be no wires or loose strands connecting **between** the two screws. Be sure UHF and VHF antennas are not mixed up and connected to the wrong terminals.
- B Test the RF amplifier tube, which is on the tuner. Typical type numbers: 2CW4, 2GK5, 3GK5, 3HA5, 3HM5, 3HQ5, 4HQ5, 6CW4, 6DS4, 6GK5, 6HQ5. Test the converter (oscillator-mixer) tube, which is also on the tuner. Typical type numbers: 5CG8, 5GJ7, 5GS7, 5KE8, 5LJ8, 6CG8, 6HB7, 6KE8, 6KZ8, 6LJ8, 9KZ8.

- C** Affects UHF only. Replace the UHF tube, found on the UHF tuner (small chassis next to VHF tuner). Typical numbers: 2AF4, 3AF4, 6AF4. NOTE: Most UHF tuners now use transistors. These must be replaced by a service technician.
- D** Test the video IF tubes—usually 2 or 3 tubes in a straight line on the chassis. Typical type numbers: 3BZ6, 4BZ6, 4CB6, 4EH7, 4EJ7, 4HM6, 4HT6, 4JC6, 4JD6, 5AN8, 5GM6, 6AR11, 6BZ6, 6EH7, 6EW6, 6GM6, 6HM6, 6HT6, 6JC6, 6JN8, 8BM11, 11BQ11.
- E** Test the video amplifier tube. You'll find it near the yellow or green wire that runs from the chassis up to the base (rear) of the picture tube. Typical numbers: 6AF11, 6GN8, 6HF8, 6JA8, 6LQ8, 8AW8, 8JV8, 10CW5, 10EB8, 10GN8, 10HF8, 10JY8, 10KR8, 10LZ8, 11KV8, 11LQ8, 12BY7, 14BL11, 14BR11, 15BD11, 16GK6. Often the video amplifier tube is a dual-function tube, and part of it is used for sync or sound IF.
- F** Overloading can be caused by too strong a signal from the station. Most modern sets can handle strong signals okay if the AGC section is working properly. Some sets have a control marked **AGC** or **Distance** (usually on the back apron of the set). Tune in the strongest station in your area. Turn the AGC control back and forth till the picture tears and is unstable. Then back off the control until the picture has normal contrast and does not bend. If adjusting the AGC control doesn't fix the trouble, test the AGC tube. Typical type numbers: 4AU6, 4HS8, 6CL8, 6FV8, 6GH8, 6GY6, 6JN8, 6LQ8, 6LX8, 8B10, 8BA11, 8JV8, 8KA8, 9A8, 10GN8, 10JY8, 11BM8, 11KV8, 11LQ8, 14BL11, 14BR11, 15BD11.
- G** Almost any tube in the set can cause this trouble. Test them all.
- H** Check the loudspeaker wires to be sure they're properly connected. If they are, test the sound (audio) output tube. You'll find it near two wires which run from the chassis to the loudspeaker. Typical type numbers: 5AQ5, 6AQ5, 6CU5, 6EH5, 6HG5, 6T10, 10JY8, 11BM8, 12AE10, 12FX5, 13V10, 12Z10, 16GK6, 17BF11, 17C5, 17CU5, 50C5.
- I** Test the other sound (audio) tubes. Often one tube performs two or three functions. Refer to your tube layout chart and look for sound IF, sound detector, and audio amplifier tubes. Typical type numbers: 3CB6, 4AU6, 4CS6, 4DT6, 6AF11, 6AU6, 6CL8, 6BN8, 6DT6, 6FV8, 6GH8, 6HF8, 6HZ6, 6LN8, 6LX8, 6T10, 8JV8, 9A8, 10GN8, 10HG8, 10JY8, 12AE10, 12BA6, 13V10, 13Z10, 14BL11, 14BR11, 15BD11, 17BF11.
- J** Test low-voltage rectifier tube. It's a large tube near the power transformer. Typical numbers: 3DG4, 5BC3, 5DJ4, 5U4. Most modern sets use semiconductor diodes instead of tubes. They are wired into the set, and must be replaced by a service technician.





- K** Be sure the set is plugged into the wall socket. Check the interlock (back cover) to be sure it's making proper contact. Check the low-voltage power-supply fuse (if used); it's usually located near the power transformer. A shorted low-voltage rectifier tube often causes a blown fuse. If several or all tubes aren't lit, your set probably uses series-string heater wiring. Check with neon-lamp tester (page 15).
- L** A weak low-voltage rectifier tube can't supply enough power to all sections of the receiver. Such a weak tube can cause narrow picture, small picture, fuzzy picture, and even complete loss of picture and sound. Sometimes testing the rectifier tube proves little. If all the symptoms are present, install a replacement tube and you'll probably fix the trouble.
- M** When you test tubes in and around the high-voltage compartment, BE CAREFUL. At the base of the high-voltage rectifier tube there's a capacitor that stores a very high voltage. It can shock you long after the set is turned off. To be safe, never touch any metal in the high-voltage compartment. If the top-cap of a tube is metal, pry it off with a screwdriver, holding ONLY the insulated handle. Then carefully remove the tube from its socket, touching NO metal.
- N** Test the horizontal output tube. You'll find it near the high-voltage compartment. It's a large tube and usually has an insulated top-cap connection. Typical type number: 6DQ6, 6GE5, 6GW6, 6GY5, 6JB6, 6JF6, 12DQ6, 12GE5, 12JN6, 17JB6, 17JN6, 18GB5, 21GY5, 21JZ6, 21KA6, 21KQ6, 22JF6, 22JU6, 33GY7, 38HE7, 38HK7. It's VERY HOT, if the set has been on awhile; use a handkerchief or dry washcloth to keep from getting burned. Also adjust the Width control, if the set has one (on the rear of the chassis).
- O** Test the damper tube—it's usually beside the horizontal output tube. Typical type numbers: 6AD4, 6AU4, 6AX4, 6AY3, 6BE3, 6CK3, 6CQ4, 11R3, 12AF3, 12BR3, 16AQ3, 17AY3, 17BE3, 17BR3, 17BS3, 17BZ3, 20AQ3, 22BW3, 33GY7, 38HE7, 38HK7. The damper is the tube that sometimes arcs and sparks. When it does, it often blows the high-voltage fuse, if one is used (or the circuit breaker). Be sure to check this fuse after replacing the tube.
- P** Test the horizontal oscillator tube, which is usually near the horizontal output tube. Typical type numbers: 5KD8, 6B10, 6CG7, 6FQ7, 6GH8, 6LN8, 6LT8, 6LX8, 8B10, 8FQ7, 8LT8, 9A8, 12BH7. When this tube is replaced, you may have to readjust the horizontal frequency or drive controls. They are usually at the back of the set.
- Q** Test the high-voltage rectifier tube. Usually it's inside the high-voltage compartment, but sometimes it's under the chassis. Typical type numbers: 1AD2, 1BC2, 1BK2, 1BL2, 1G3, 1K3, 1X2, 2AS2, 3A3, 3AT2. BE CAREFUL when replacing this tube. Refer to M above.



- R** Check the picture-tube heater (at the base or rear of the tube) to see if it's lit. If it isn't, the heater is probably burned out. In older sets, the wires sometimes come loose inside the pins of the picture-tube base, and you may be able to resolder them. See Picture Tube Tips, on page 28. Peek in through the top of the back cover as you turn the set on. If you see arcing, flashing, or a large purple glow inside the neck of the picture tube, it's defective. (A tiny blue glow is not abnormal in most picture tubes.) Call your local service technician.
- S** The most common trouble symptom of an ailing picture tube is that the picture comes on very slowly when you turn on the set, and even then it's very dim. Turn up the brightness control; if the white areas of the picture appear silver and sparkle-y, you have a weak picture tube. Try a tube brightener. If there's one already on the tube, you are ready for a new picture tube. Call your local service technician to install it; that's not a job for the inexperienced.
- T** Test the vertical oscillator and the vertical output tubes. They may be two separate tubes, or a single dual-function tube. Typical type numbers: 6EM5, 6EM7, 6FY7, 6JZ8, 6KY8, 8AW8, 8BA11, 9A8, 10CW5, 10DE7, 10GK6, 10GV8, 13FM7, 13GF7, 15KY8, 16GK6, 17JZ8, 21LR8, 23Z9.
- U** Test all the sync (synchronizing) tubes. Often one part of a dual-function tube is used for sync. Typical type numbers: 4HS8, 6AF11, 6AV6, 6FQ7, 6GH8, 6GN8, 6JA8, 6LN8, 6LX8, 8B10, 8BA11, 8JV8, 8KA8, 9A8, 10EB8, 10GN8, 10JY8, 10KR8, 10LZ8, 23Z9.
- V** This symptom can be caused by a defective yoke, which is a coil of wire around the neck of the picture tube. Replacing the yoke is a job for a qualified technician.
- W** To correct a tilted picture, you must rotate the yoke (the coil of wire around the neck of the picture tube). Loosen the wing nut that holds the yoke in place. With set operating, rotate the yoke slowly until the picture is square on the screen. Then tighten the nut. BE CAREFUL not to touch metal or wires when you make this adjustment; touch only the plastic cover of the yoke. Caution is always advisable whenever you reach inside the cabinet while the set is on.
- When the picture isn't centered, you must adjust the flat centering tabs around the picture-tube neck behind the yoke. There are two; move both until you bring the picture to center. In some older sets, a single large centering tab is held solid by a wing nut. Loosen the nut and move the metal tab around until the picture is centered. Then tighten the nut. These adjustments require patience. Take your time.
- X** A picture shrunk or stretched vertically, or a picture out of proportion vertically, means you should test the tubes indicated at U. If that doesn't cure the trouble, adjust the height and vertical lin-



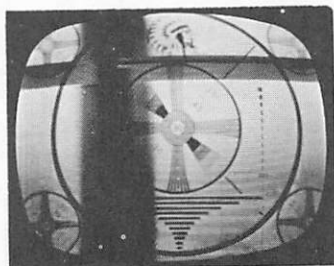
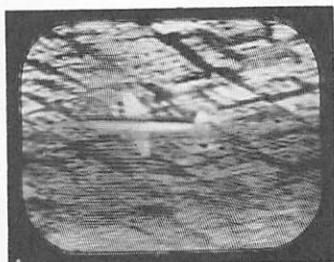
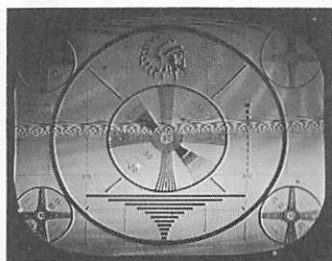
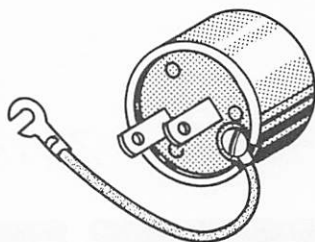
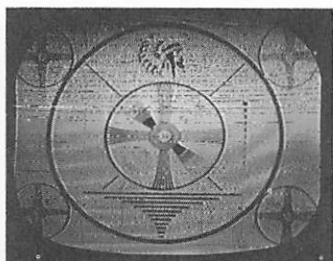


earity controls. These controls are usually on the back panel, but sometimes are accessible from the front of the set through the "soap-dish" panel that houses some of the operating controls. You must adjust **both** height **and** vertical linearity, because each one affects the other. Take your time and eventually you'll get the picture right. If the tubes are okay and you still can't get a correct picture, some other part — maybe a resistor or capacitor — is at fault. Consult your service technician.

### Interference Troubles

Trouble with your TV set can be caused by **interference** as well as by faulty parts. There are several types of interference. You may be able to fix some of the troubles it causes by following these hints.

**Motor interference** fills the screen with black-and-white streaks. You may also hear a buzzing in the sound. This interference is caused by a



dirty electric motor (or dirty motor brushes) in such appliances as vacuum cleaners, electric shavers, refrigerators, sewing machines, and food mixers. Sometimes you can eliminate or minimize this interference by installing a noise or line filter at the offending appliance, between its power plug and the wall socket.

**Power-line interference** shows up as a strip or band of black-and-white streaks across the picture, and noisy sound. If you live in a fringe area and are near a high-voltage power line, you may get this interference. It's often caused by a cracked insulator on the line, or similar trouble. If the problem persists, call your power company and make a polite complaint. They usually have troubleshooters who can correct it.

**Diathermy interference** causes "fishbone" patterns in the picture and a loud hum in the sound. This trouble is caused by medical and surgical equipment in a nearby hospital or doctor's office, and generally is worst on Channel 5. Sometimes, changing the direction of your antenna eliminates or minimizes this interference. Usually, though, it can be eliminated only at the source.

**RF interference** is similar to diathermy effects, but the "fishbone" pattern covers the whole screen. It's usually caused by a neighboring TV set that's faulty, or a nearby CB, ham, or broadcast radio transmitter. If the trouble persists, consult your service technician.

"Ghosts" are caused by your antenna pointing the wrong way, and picking up multiple images from the TV station. Try turning your antenna. If you use rabbit ears, relocate them in a different part of the room. If you can't get a ghost-free picture on an indoor antenna, you may have to install an outdoor type. Ghosts that appear, go "swish-swish-swish," get faster and faster, and then disappear, are caused by airplanes flying over (the effect is called "airplane flutter").

**Co-channel interference** is most noticeable in the late spring and early summer, because of atmospheric effects. It's sometimes called "windshield wiper" effect or "venetian-blend" effect. Your antenna is picking up not only the signal from your local station, but the signal from another, distant station on the same channel. If the trouble continues, try turning or repositioning the antenna. Sometimes a sharply directional outdoor antenna is the only solution.

## Fuses

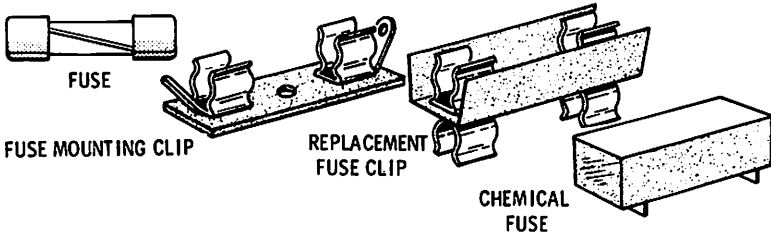
Faulty tubes are not the only cause of troubles in your TV set. As mentioned earlier, a blown fuse can cause your set to go dead—no picture, brightness, or sound. You usually can't tell a bad fuse by just looking at it. To make sure, test it (see page 15), or substitute a new one. You may want to keep a few spares on hand to substitute.

Some sets have a low-voltage power-supply fuse located near the power transformer. This fuse usually has a rating of 1 to 5 amperes.

Many modern TV sets use "chemical" fuses for low-voltage protection. You can test these the same way you test other fuses.

The high-voltage power-supply fuse is near or inside the high-voltage compartment. This fuse has a rating of 2/10 to 7/10 amperes.

Often, a high-voltage fuse blows because the damper or horizontal output tube is bad. If so, replace one or both of these tubes and the problem is solved.



If you replace a bad fuse and it blows again, there's probably a short in the set. Test the tubes. If that fails to cure the trouble, consult your service technician.

### Fusible Resistors

The fusible resistor looks different from a regular fuse—it has a sandy coating. But it does the same job. It blows and breaks the circuit if there's a short circuit. Like some fuses, it plugs in somewhere on the chassis. And, as with a fuse, if a fusible resistor fails repeatedly, you can bet there's an overload somewhere in the set.



### Picture Tube Tips

The most common cause of a dim picture in old sets is—believe it or not—dirty glass in front of the picture tube. The glass collects dirt and grime which darken the picture. You'll have to remove the safety glass and clean both sides, as well as the face of the picture tube. Generally, all you do is take out a few screws along the top of the glass, remove the metal or plastic molding, and tip out the glass. Some sets don't come apart this way; for them, it's wise to call in your service technician. He'll have to remove the back of the set, take out the chassis and picture tube, and clean the safety glass from inside the cabinet.

If you have a late-model set, all you need to do is clean the front of the tube. The safety shield is bonded to the picture tube, and you can't separate them.

To wash the safety glass or the face of the picture tube, wipe it with a soft rag or sponge, wrung out in a little detergent and warm water. Use another rag and clean water to rinse; then dry with a lintless paper towel or cloth. Clean a bonded-tube face once a month. In old sets,

clean the inside of the glass and the picture-tube face two or three times a year.

**BE VERY CAREFUL** around the picture tube. If you break it, the resulting implosion could cause flying glass fragments to cut you seriously. If the picture tube is bad, have your technician replace it. He has the equipment to test it properly, and the tools and know-how to replace it safely.

### **Arcing**

When the insulation on a wire breaks down, cracks, or melts, the voltage in the wire may jump sharply to the chassis or to another wire. This is known as **arcing**, and it happens most easily in the high-voltage section of the set. Sometimes, you can hear the electricity cracking or popping. Remove the screws from the top of the back, and pull the back out slightly, leaving the set turned on. Don't touch anything inside, but look carefully. You can usually see the point of arcing.

When an arc pierces the insulation on a high-voltage wire, that wire is ruined. Replace it, or have your service technician do it. As a stopgap measure, you can move the wire away from the chassis, or wrap it with plastic tape. The only sure cure, however, is to replace it with new high-voltage wire.

### **Corona**

Corona is a sort of voltage discharge into the air; it hisses or makes a frying sound. It looks like a bluish or purplish glow around a wire or component part. You can't see corona with the room lights on, but if you operate the set in a dark room and look into the back, you may be able to spot it. Corona occurs most often at a sharp point on a solder connection or wire.

Curing corona is usually a job for your service technician. If you want to try, you can buy a chemical, sometimes a spray can and sometimes in a bottle, which you can spray (or paint) on the area causing the discharge. Corona is worst in damp, humid weather; it may go away in ordinary weather.

### **No Control of Brightness**

If you can't adjust the brightness on your set, it's usually because you have either a bad control or a bad picture tube. Other tubes hardly ever cause this problem. Consult your service technician.

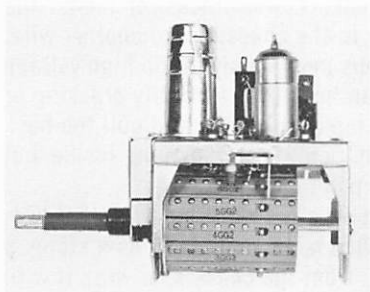
### **Cleaning the Tuner**

A dirty VHF tuner is a common fault. Just as the picture tube gets dirty, dust and grime build up on the tuner switch contacts, and they

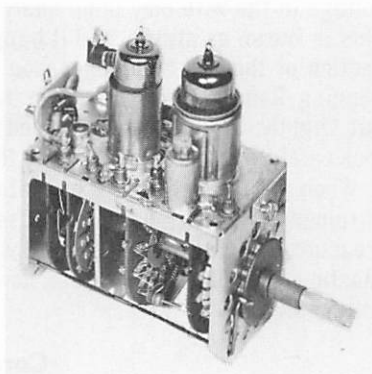


make a poor connection. If you have to wiggle the channel selector, or hold the knob between channel positions to get a clear picture and sound, your VHF tuner probably needs cleaning. You can't clean the UHF tuner, but usually it doesn't get dirty anyway.

To clean the VHF tuner in most sets, you'll have to remove the chassis from the cabinet. Take out the bottom bolts and disconnect the wires to the picture tube and yoke (if they're mounted on the cabinet), and to the loudspeaker. Then remove the thin U-shaped metal cover around the tuner, exposing the switch contacts.



TURRET TYPE TUNER



SWITCH TYPE TUNER

At most tester locations — and at all radio-TV service shops — you can buy an aerosol cleaner. Be sure to buy a type of cleaner that doesn't melt plastic; some new tuners have plastic inside them. Place some rags or newspaper under the tuner to catch any spilled cleaner, and make sure the liquid can't leak down onto the chassis. Spray the switch contacts with the cleaner, rotating the channel selector dial as you do so. As you rotate the dial, the cleaner mixes into the switch contacts and cleans them.

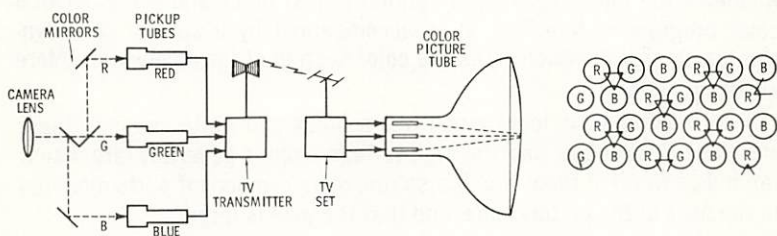
Don't use too much spray cleaner. Wipe off any excess with a clean, lintless rag, or a paper towel. Be careful not to catch the rag on the switch contacts and leave fragments or threads. After the cleaner has dried, lubricate the contacts. You can buy tuner lubricant, too, at radio-TV service shops.

Re-install the U-shaped metal protective cover on the chassis. Then put the chassis back into the cabinet and remount the bolts. Be sure you reconnect all the wires you disconnected. Take your time cleaning the tuner — it's a delicate job.

# BASIC COLOR-TV THEORY

All colors may be made by mixing various amounts of three basic or primary colors. In color TV, red, green, and blue are the primaries. To produce violet, for instance, red and blue are mixed.

The diagram shows basically how the color-TV system works. At the station, the color camera has three pickup tubes. (A black-and-white camera has only one.) Light from the studio scene passes through the camera lens and then through color mirrors. The mirror at the top allows only red light to pass it and reach the top pickup tube. This tube is called the red tube. The other two tubes are for green and blue, and they work with mirrors the same way.



The three color signals are then processed by the transmitter and broadcast. At your house, the TV set recovers the color signals, and feeds them to the color picture tube. In this tube there are three electron beams. (The black-and-white picture tube has only one.) Each beam carries information for only one color—red, green, or blue. All three beams together are swept back and forth and from top to bottom, exactly as the one beam is swept in a black-and-white picture tube.

The screen of the color picture tube contains thousands of tiny colored-phosphor dots. They are arranged in groups of three, as the diagram shows. Each group has one red dot, one green dot, and one blue dot. The electron beam for each color strikes only its own dots, and lights them up. The mixture reproduces the studio-scene colors on the screen.

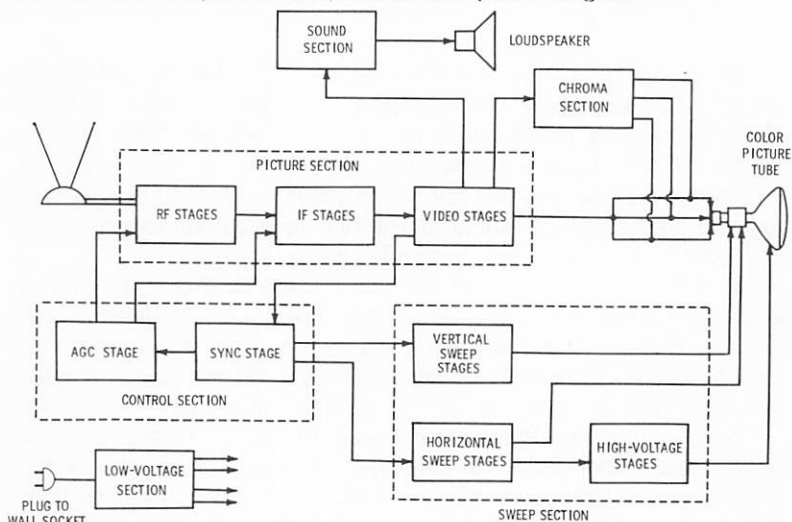
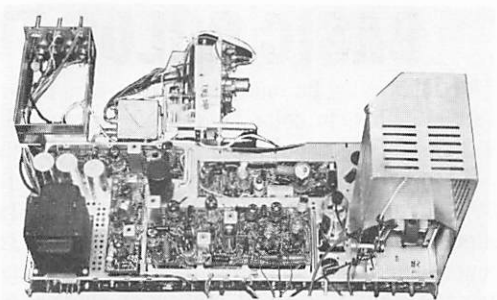
The dots are so tiny that you can't see them unless you get very close to the screen. When you are at the proper viewing distance of ten feet or so, the lighted dots merge into a colored picture. As an example: If one area of the picture is very red, only the red beam is on when the beams sweep over that area; so, only the red dots are lit. The green and blue beams are turned off, so the green and blue dots are dark. In this way, the picture duplicates the scene at the TV station.

The signal for a color program contains the same black-and-white picture (video) information that the studio scene would contain if it were televised by a black-and-white TV camera. That's why a black-and-

white receiver can reproduce any TV program, even though the program is televised in color.

A color program, then, is merely an ordinary video signal with color signals added. Therefore, a black-and-white program (one without the added color signals) can be reproduced in black-and-white by a color set. The color circuits in the color set are turned off whenever the incoming program signal is just black-and-white. When a color program is televised, it is accompanied by a special color-synchronizing signal, which turns the color section of the receiver on. (More about this later.)

A color-TV chassis looks much like a black-and-white chassis. There are a few more tubes, and the high-voltage cage is generally larger so it can hold several of them. You'll also find more component parts mounted on the neck of the picture tube, and that the yoke is larger.

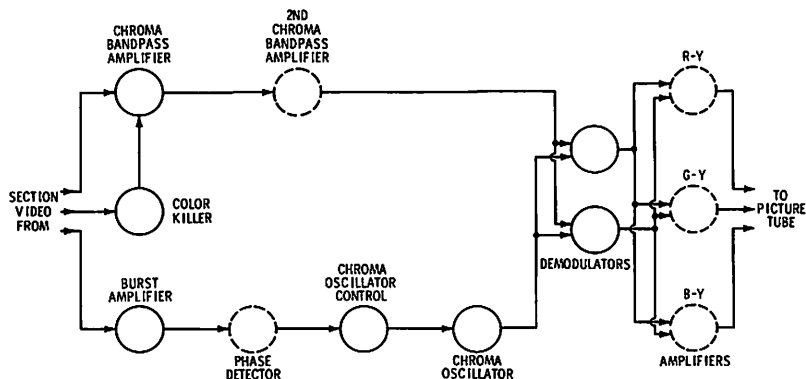


This block diagram of a color-TV set, looks very much like the block diagram of the black-and-white set, on page 3. There is very little difference between the two. Both process the TV signal in separate video, sound, and sync stages. There is, however, one added section—the **chroma** section. It extracts the color information from the TV signal, and controls the three color beams in the picture tube.

There are minor differences in the other sections of the color set. In the sweep section, some tubes are bigger and more powerful, because the color picture tube requires more power. The high-voltage section sometimes contains two additional tubes—a **focus rectifier**, which controls picture focus, and a **high-voltage regulator**, which keeps the high voltage constant.

Most color sets have a **blinker tube**, which turns off the beams in the picture tube while they snap back over to the left side to begin another line of sweep. And a few sets use a **pincushion corrector tube**, to stop the picture from having a bowed, pincushion shape.

The diagram here shows the common tubes used in the chroma section. The circles shown in dashed lines represent tubes not used in all sets.



Color information is recovered in the video section of the receiver. It is fed from there to three tubes. The first tube, the **chroma bandpass amplifier**, amplifies (strengthens) the chroma signal from which will be extracted the three colors that were produced by the station camera. Sometimes two chroma bandpass tubes are used for greater amplification.

The **burst amplifier** extracts and processes the **color burst**, which is the synchronizing signal for colors. Color sync is needed to make sure the set reproduces the original colors accurately. Sometimes, a **phase detector** tube compares the incoming burst with a special signal generated in the chroma section (semiconductor diodes may be used, instead of a tube). Next comes the **chroma oscillator** tube (which generates the "special" signal—called 3.58 signal). The burst or color-sync signal controls the chroma oscillator. The output of the chroma oscillator tube is fed to the **demodulators**, where it is mixed with the signal from the bandpass amplifier.

The two demodulator tubes convert the chroma information recovered from the video signal into red, green, and blue. Some demodulators



have sufficient output to be fed directly to the color picture tube. Others don't, and their signals are fed first to three amplifier stages, called **R-Y, G-Y, and B-Y**.

You may notice the **color killer** tube. If the set is receiving a color program, the color killer receives the burst or color-sync signal, and sits there and does nothing. All other chroma tubes operate normally, and the picture tube receives color information. But if a black-and-white program is being received, there is no burst (color sync). In this case the color killer turns off the chroma bandpass amplifier tube(s), stopping color information from getting to the demodulators and picture tube. Thus the picture tube receives only black-and-white video information, which comes to it directly from the video amplifier.

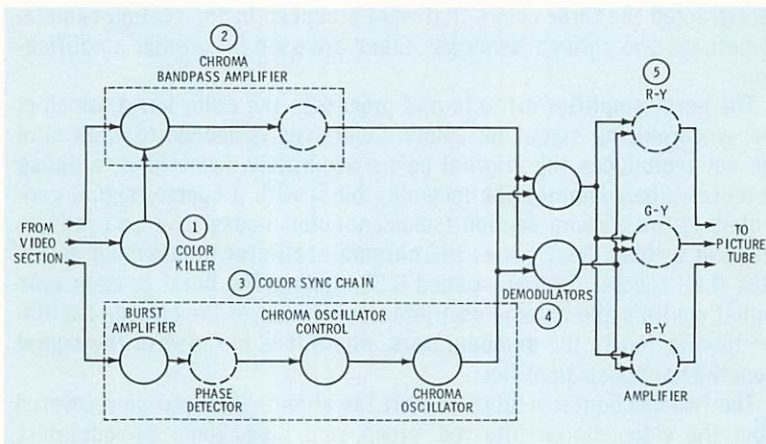
In some receivers, signal flow is slightly different from that in the diagram on this page, but the stages and their functions are the same. The names of stages on the tube-layout chart of your color set correspond closely with those given.

### Color Tube Troubles

As you learned earlier, when a tube is weak, it may do its job, but not very well. If the tube is dead, it doesn't do its job at all. And, if the tube is shorted, it often blows a fuse, killing the whole set.

Each tube has a specific job. So, if you know what symptoms to look for, you can often pick out the bad tube by watching the screen. Remember that the black-and-white sections of a color set still work as they do in a black-and-white set. If the picture rolls vertically, the trouble is in the vertical sweep section—not in the chroma section. With a few exceptions, color-tube defects cause only color troubles.

1. A faulty color killer has two effects. During a black-and-white program, you see scattered color flecks in the picture. This is sometimes



- called **color snow**, or **confetti**. During a color program, the color may disappear from time to time, or it may be missing entirely.
2. A defective chroma bandpass amplifier tube causes intermittent or complete loss of color. If the trouble comes and goes, so does the color. The color may be good when it's there, but it doesn't stay. Also, this tube may make the colors run together, like different colors of paint when they're mixed.
  3. The most cause of colors "running" is a defective tube among the color-sync stages. When one of these tubes goes bad, it interrupts the synchronization of the color information. The chroma is still being fed through the bandpass amplifier to the demodulators and the picture tube. But this chroma information is not "in step" with the color images at the studio camera. Thus the color is random, and usually moves around on the screen even though the video part of the picture is stable.
  4. If a demodulator tube is defective, you get odd colors on the screen. You can't get normal color. You may—for example—get weak bluish-green color, with no red.
  5. If one of the R, G, or B amplifier tubes is faulty, you will lose one color. E.g., if the red amplifier is defective, the entire screen becomes bluish-green, even during black-and-white programs.

## **ABC'S OF COLOR-TV**

### **TROUBLESHOOTING**

It's easy to troubleshoot a color set, once you've learned to fix a black-and-white TV. Most sections of the two sets are the same. The main difference is that the color set contains the chroma section, and several extra tubes.

The first step in troubleshooting a color set is to make sure the black-and-white sections are operating properly. You should see a sharp, correctly proportioned picture, and hear the sound clearly. Turn the color control all the way down, to leave color information out of the picture. Make any necessary tests and adjustments, following the tips on pages 19-26.

When you are sure the black-and-white section is okay, go on to the color section. If the color is bad or completely lost, these pages will help you cure the trouble. Use the tube-layout chart on the inside back of the set to find the right tube. On these pages you can also see sample layout charts from modern color sets.

- A** Adjust the focus control at the rear of the set. (Some sets don't have one.) If the control has no effect, test the focus rectifier tube. Typical type numbers: 1V2, 2AV2, 2BA2. Some sets now use semiconductor diodes as focus rectifiers, which you cannot test. Consult your service technician.
- B** Test the burst amplifier. Typical type numbers: 6AF9, 6BL8, 6BW11, 6EW6, 6GH8, 6JC6, 6LN8, 8AW8, 8BU11. Test the chroma phase detector (also called the chroma-sync detector). Typical type numbers: 6BN8, 6JU8. Some sets use semiconductor diodes for this function. Refer also to D below.
- C** This condition is caused by improper **convergence**. (The three electron beams don't strike their own color dots on the screen.) Converging a color set requires special equipment and training. Consult your service technician.
- D** Turn the fine-tuning control back and forth. You can't get any color if the fine tuning isn't properly set. If you can't get color at any setting of the fine-tuning control, it probably isn't at fault.  
If you have snow in the picture, the incoming station signal is weak, and you may not get any color. The set requires a strong, clear black-and-white picture before it can produce color. Correct as for black-and-white troubles (A, B, C, D, F on pages 19 and 21).  
If the black-and-white picture is normal and you still don't get color, test the color killer tube. Typical type numbers: 6GH8, 6JU8, 6KT8, 6LY8, 6M11, 8BU11, 10JT8. Test the chroma bandpass amplifier(s). Typical type numbers: 6BL8, 6BW11, 6DX8, 6EW6, 6GH8, 6KT8, 6X9, 8AW8, 8BN11, 8BQ11. Test the chroma oscillator control tube. Typical type numbers: 6BL8, 6GH8. Test the chroma oscillator tube (also called 3.58-MC or CW oscillator.) Typical type numbers: 6GH8, 6KT8.
- E** The picture tube needs demagnetized, or needs purity adjustment, or convergence is out of adjustment (see C above). These cures are a job for a properly trained and equipped service technician.
- F** Test the horizontal oscillator tube. Typical type numbers: 6BH11, 6BL8, 6CG7, 6FQ7, 6LT8, 6U10. Test the horizontal output tube. Typical type numbers: 6JE6, 6JS6, 6KD6, 6KM6, 6LB6, 12GE5, 21LG6, 23JS6, 40KG6, 42KN6. Test the damper tube. Typical type numbers: 6BS3, 6CE3, 6CG3, 6CJ3, 6DW4, 12AX3, 12DW4, 19CG3, 34CE3, 43EC4. Test the high-voltage rectifier tube. Typical type numbers: 1AD2, 3A3, 3AT2, 3AW2, 3BS2, 3CU3, 3CX3. Test the high-voltage regulator tube. Typical type numbers: 6BK4, 6EF4, 6HS5. (A good many sets don't have a high-voltage regulator tube.) Check the focus rectifier, if one is used (see A above), the video output tube, and the high-voltage power-supply fuse. Also see J on page 39.





- G** Almost any tube in the set can cause this trouble. Test them all.
- H** Test all color demodulator tubes. Typical type numbers: 6BL8, 6BV11, 6GH8, 6GY6, 6HZ6, 6LE8, 6ME8, 12AZ7, 12BV11. Test R-Y, G-Y, and B-Y amplifiers, if used. Typical type numbers: 6AC10, 6BL8, 6GH8, 6GU7, 6MD8, 8FQ7, 9EA8, 12MD8. This trouble can also be caused by a defective picture tube, in which case see your service technician.
- I** Test pincushion corrector tube. Typical type numbers: 6GH8, 6KT8. Some sets use a transistor or diodes for this function.
- J** Test horizontal blanker tube. Typical type numbers: 6GH8, 6GU7, 8FQ7, (Some sets don't have a tube for this.)
- K** Improper vertical size (height) isn't a color trouble, but it's included here because most color sets use different vertical sweep tubes than black-and-white sets. Test the vertical output tube. Typical type numbers: 6CW5, 6FM7, 6GF7, 6HE5, 6LU8, 10CW5, 11FY7, 16AK9, 21LU8.

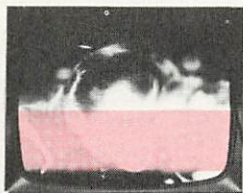
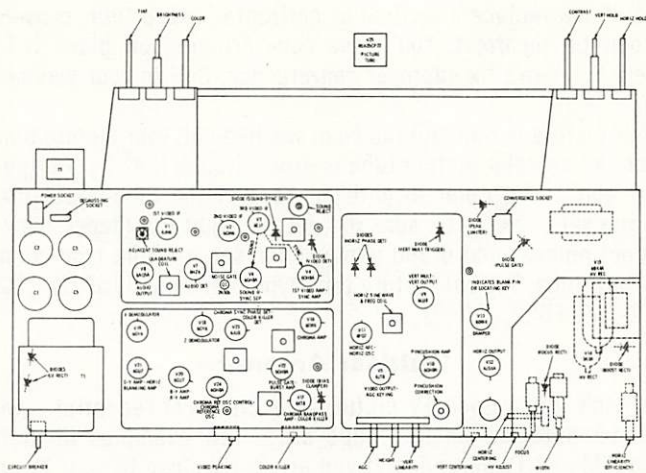
### **Color Adjustments You Can Make**

Some adjustments to a color set should be made only by a service technician with proper training and equipment. Still, there are a few simple adjustments you can make that will save you money. Just be careful, and adjust nothing not specifically mentioned below.

After you have replaced defective tubes, you should check these adjustments, to be sure they're set properly.

1. Adjust Width, or Horizontal Size, until the picture fills the screen and seems correctly proportioned. If a Horizontal Linearity control is used, adjust it also. Don't touch the Horizontal Efficiency control; it requires special equipment for adjustment.
2. Adjust Height and Vertical Linearity until the picture fills the screen and is correctly proportioned.
3. Adjust Horizontal and Vertical Centering controls until the picture is in the center of the screen, with no shadows at the edges. Adjust only those centering controls which are on the chassis. Don't adjust any tabs or magnets on the picture-tube assembly. You may have to repeat steps 1 to 3 to get a centered picture which fills the screen.
4. Adjust the focus control for a sharp picture.
5. Adjust the AGC, Area control, or Fringe Lock control. Tune in the strongest channel in your area, and adjust the control until the picture breaks up and looks too harsh and contrasted. Then back the control off slightly until the picture is steady and clear.
6. Adjust the Video Peaking control. This adjustment makes the picture crisper, by making the edges and outlines of picture objects stand out. Adjust it for cleanest picture.





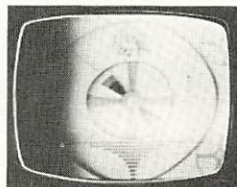
BAND IN PICTURE; SOMETIMES  
HUM IN SOUND.  
REMEDY: G



PICTURE TOO REDDISH GREEN,  
OR BLUE; SOUND OK.  
REMEDY: H



BOWED SHAPE OR "PINCUSHION"  
AT TOP (OR BOTTOM); SOUND OK.  
REMEDY: I



SCREEN DARK AT LEFT SIDE;  
WHOLE SCREEN MAY GET DIM;  
SOUND OK.  
REMEDY: J



INCORRECT VERTICAL SIZE  
OF PICTURE; SOUND OK.  
REMEDY: K

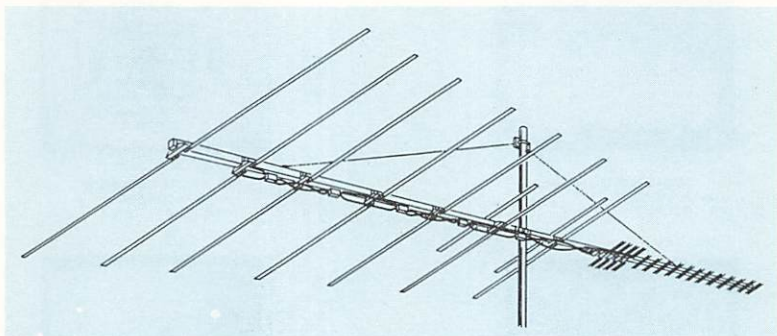
NOTE: PHOTOS ARE IN ORDINARY BLACK- AND-WHITE PHOTOGRAPHY FOR SIMPLICITY, BUT ARE TAKEN FROM COLOR SETS.

Note: If you replace a vertical or horizontal sweep tube, convergence may then be incorrect. You'll see color fringing on black-and-white pictures. You can't fix improper convergence. Call in your service technician.

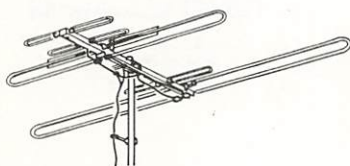
If your picture is dim and the color washed-out, your picture tube may be weak. A new color picture tube is expensive, so first try a brightener. Be sure you buy a **color** brightener. Look at the tube-layout diagram inside the set back. To be sure you get the right brightener, copy down the model number and brand name of the set, and the type number of the picture tube. Typical picture-tube type numbers: 11SP22, 21GFP22, 25AP22A, 490EB22, 25CP22, etc.

### Outdoor Antennas

You can't get a good TV picture—or clear FM reception—without the proper antenna. On this page are a few examples of the many kinds of FM and TV antennas. If you are fairly close to your TV and FM stations, you can probably get by with indoor or simple outdoor antennas.



UHF-VHF-FM ANTENNA



VHF-ONLY ANTENNA



UHF-ONLY ANTENNA



FM-ONLY ANTENNA

However, in heavily built-up portions of big cities, with tall buildings, "ghosts" are produced (page 26.) The TV signals are bounced off buildings and you pick up several images. You may need a highly directional antenna. Farther out from the stations, where signals are weak, you will

probably need an antenna with many elements, which picks up lots of signals.

An outdoor antenna can give good reception for 2 to 6 years, and the lead-in wire can last from 1 to 3 years, depending on where you live. All antennas corrode from exposure to weather, smoke, and smog, and gradually your picture gets worse. In many cases, you can find and correct antenna trouble yourself.

1. Check the lead-in wires at the back of the set. They should be firmly connected to the two antenna-terminal screws, and the wires should not be broken. There should be no wire or other metal connection between the two screws.

Most TV sets built since 1964 have two sets of antenna terminals — one for VHF and one for UHF. You may have a single antenna for both; a jumper (an 11-inch piece of lead-in wire) can be connected between the two sets of terminals. In some locations you get better pictures by using two separate antennas. Be sure each is connected only to its proper terminals.

2. Check the lead-in wire(s) from the set to the antenna(s). If the lead-in is broken, you won't get a clean picture or good FM reception. If you have a color set, you won't get steady, good color.

Look at the lead-in for breaks. Watch for places where the wire touches metal, like a drain pipe or roof gutter. When the lead-in touches external metal objects, you lose some of the TV or FM signal. You may get flashes and intermittent snow in the picture, when the wind blows. The lead-in is probably bad and needs replacing.

3. A lightning arrester should be part of every outdoor antenna installation. Otherwise, a static-lightning discharge can travel down the lead-in wire and destroy parts in your TV set.

A shorted lightning arrester can kill reception. To check it, disconnect it temporarily. (DON'T DO THIS with storm clouds around.) If the picture improves, the arrester must be replaced. Be sure the wire from the arrester to the ground rod is in one piece, is mechanically secure, and makes solid connection to a copper ground rod driven 8 feet into the ground. Also be sure the antenna mounting pipe or mast is securely grounded to the same ground rod by a heavy copper or aluminum wire.

4. If you replace any lead-in wire, replace it all — from antenna to TV set. Replace stand-off insulators at the same time.

While you're at it, take down the antenna and clean the elements and lead-in terminals with steel wool. When you remount the antenna, be sure it's aimed properly. Have someone switch to each channel on the TV set while you turn the antenna back and forth. Try for a direction that gives you the best picture on all channels.

# RADIO TROUBLESHOOTING

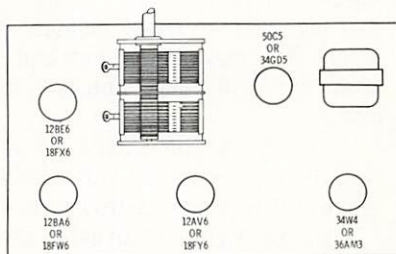
If you have learned TV troubleshooting, you won't have any difficulty with radio, because it's easier. A radio uses only a few tubes, and there are no picture, sweep, or high-voltage circuits; so you needn't worry about which section the trouble is in. Just test all the tubes and replace the bad ones.

## Table and Console Models

When a radio goes dead, first make sure it's getting power. Unplug it from the wall socket and plug in a lamp to see if there's power at the socket. If there is, take the back of the radio off and put the test prods of a neon-lamp tester across the two power-cord wires inside the chassis. Being very careful that you don't touch any bare spot, plug in the set. If the neon lamp lights, voltage is reaching the set; if not, the power cord is defective and should be replaced.

You can buy power cords and plugs in many hardware stores. To install a new cord, unsolder the old wires and remove them from the chassis. Then thread the new ones through the access hole, strip the insulation from the ends, and solder them in place.

If you find that the set is getting power, but still isn't working, it's time to test the tubes. On the bottom of the cabinet, or inside the back, you'll likely find a tube layout chart. A sample chart shown here, shows the most common tubes used in small table-model radios. Be sure you get the tubes back in their proper sockets.



Many table-model radios use the series-heater arrangement you learned about on pages 15 and 16. So, if all the tubes in your radio are out (not lit), try the neon-lamp tests. You'll probably find one of the tubes is burned out; when you replace it, the radio will work normally.

If the dial lamp burns out, replace it right away. If you don't, an extra load is placed on the rectifier tube and it may burn out shortly. If the dial lamp burns out repeatedly, replace the rectifier tube and you'll probably fix that trouble.

Hum that remains when you turn the volume down is usually caused by a defective filter capacitor. This hum may also be accompanied by a squealing, "putt-putting" sound, like a motorboat. Replacing a filter capacitor is a job for a trained service technician. A few hum problems can be caused by shorted power-output tubes. Typical type numbers: 6AQ5, 5BQ5, 6V6, 34GD5, 35C5, 35L6, 50B5, 50C5, 50L6.

Sometimes the volume changes when an appliance, like a vacuum cleaner, is turned on. This is often a symptom of a weak rectifier. Typical type numbers: 5Y3, 6CA4, 6X4, 6X5, 35W4, 35Z5, 36AM3, 50DC4. In some cases, however, this volume change is caused by the set using the power line as an antenna. Reversing the power plug in the wall socket often fixes this trouble.

### **Portable Radios**

Today, tubes aren't used in portable radios. Instead, they have transistors. You can't replace them, for they're wired into the set; furthermore, direct replacements aren't often available. Consult a service technician who specializes in these portables.

The purchase price of an inexpensive transistor portable is often so low that it's not worth having repaired by a technician, whose time is worth several dollars an hour. Luckily, transistors don't fail as often as tubes do.

The most common cause of a portable going bad is a weak battery. Sometimes you put in a new battery one day and the set won't work the next. You might have bought a battery that was on the shelf too long and already weak. Or you might have accidentally left the radio on with the volume turned down. Since portables don't have pilot lamps, it's often difficult to tell when a radio is on.

If you use a transistor radio a lot, don't use ordinary batteries. Pay a little more and get longer use with mercury or alkaline batteries. They're worth it, since they don't run down as often. In a few battery types, you can buy the new nickel-cadmium batteries, which are rechargeable.

When you replace batteries, check the contacts of the battery holder or connector in the radio. If they're not bright and shiny, work them over with a piece of sandpaper until they are. Dirty or corroded contacts can cause the radio to go dead or the sound to be distorted.

### **Car Radios**

Since 1963, auto radios have used transistors rather than tubes. You can't do much about most troubles in such radios, except consult your service technician.

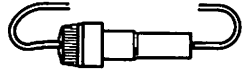
In the early 1960's, cars used hybrid radios. The output stage is a transistor, but the other stages are tubes. Typical type numbers: 12AC6, 12AD6, 12AF6, 12BL6, 12CN5, 12DE8, 12FK6, and 12GA6. You can test these tubes just as you would any other. If replacing them doesn't fix the trouble, the output transistor may be defective; consult your service technician.

If your car radio is completely dead, the fuse may have blown. You'll find it in series with a wire from the radio chassis to the power wiring



in the car. The fuse-holder looks like the diagram. There may be another fuse in the car's fuse block; be sure to check there too. Test the fuse as described on page 27 and at the bottom of page 15.

No radio can work very well without a good antenna and connecting cable. You can test the antenna yourself by substituting a new one. Place the new antenna on the car seat and plug the new cable instead of the old one into the side of the radio chassis.



If you can't borrow a new antenna and cable, you can make a simple test by substituting a piece of insulated wire 6 or 8 feet long. Strip the insulation off the end of the wire for about a half-inch. Then unplug the existing cable from the side of the radio chassis. Insert the test wire in the center-pin hole of the antenna socket. Make sure the other end of the wire isn't touching the car body. If you get better reception with the wire, the antenna or its cable is bad. Replace them.

You can also check the adjustment of the **antenna trimmer** on the car radio. You'll find a knurled bolt or screw on the side of the chassis near the antenna-cable jack. Tune in a weak AM station around 1400, and turn the knurled bolt back and forth slightly until the station sounds strongest.

Your antenna may be noisy. Turn in a weak station on the car radio and turn the volume high. Turn off the car engine. Stand outside and pull the antenna up full. Then pull it to one side and let it spring back. You'll notice a change in volume when you grab the antenna and let it go; that's normal. But if you hear a change in volume as the antenna springs back and forth, the antenna is dirty and noisy. Replace it and the cable.

## FM Radios

Many table models, consoles, portables, and car radios tune the FM band. Most of what you have read so far applies also to FM models. The same broadcast-band circuits are used, but FM band is extra. There is one major difference: FM circuits are more critical than AM (standard) radio circuits. Thus, you must be more careful than ever to get the tubes back into the tube sockets after testing them. Also, a tube may test good in the tube tester, yet not work satisfactorily in the FM set. The only way to test such a tube is to substitute a new one for the suspected bad one.

The FM circuits (except in auto AM-FM radios) also use an antenna separate from the AM (standard) antenna. In many places, a line-cord FM antenna (supplied with the radio) works fine. A length of wire from the FM antenna terminal is included alongside the power cord. This antenna wire is not connected electrically to the power cord. Such a line-cord antenna is not efficient everywhere, and if you don't pick up stations clearly, you should try a better antenna. One of the simplest

is TV rabbit ears. If you live farther than 10 or 20 miles from FM stations, you may find an outdoor FM antenna useful; it will pick up more signals. (See the section on outdoor antennas on page 40).

### **Shortwave Radios**

Many radios today tune one or more shortwave bands, which means you can listen to broadcasts direct from foreign countries. The shortwave bands are added to a regular radio just as the FM band often is. You can troubleshoot such radios as you would any other. Some tubes are very critical, and perhaps the only reliable test is to substitute a new tube for the suspected bad one.

A shortwave radio needs a good antenna to pick up foreign broadcasts. Though some of these radios can get by with only a few feet of wire laid along the floor, others require 20 or 30 feet of wire outside. The shortwave antenna connection is usually separate from the AM and FM terminals.

### **Phonographs and Record Changers**

Phonographs and record changers are also often called hi-fi's. They use several tubes, and you can troubleshoot them pretty much as you would a radio.

Small record players contain one to three tubes. Some small phonographs use only a single tube, wired in series with the motor. If the player is completely dead, check the tube; if it's burned out, the motor won't turn. Larger phonographs generally contain two to six tubes.

A shorted tube is the cause of a great many hum problems in phonographs. Watch carefully for any sign of one.

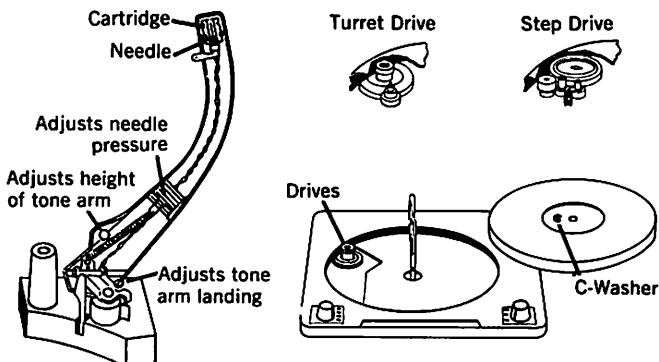
A tube that checks gassy on the tester is likely to cause distortion, and a weak or dead tube can make your phonograph work poorly or not at all.

Most phonographs have tube-layout charts inside the cabinet—just like TV's and radios. Be sure you get the tubes back in the correct sockets after testing.

### **Mechanical Problems in Phonographs**

Mechanical repair work on phonographs and record changers should be done by a service technician who specializes in such jobs. The mechanisms are delicate and balanced, like the parts of a watch. If you don't know what you're doing, it's easy to damage the parts.

There are, however, simple repairs you can make. The turntable on most changers is driven by a rubber wheel turning against the inside of the turntable rim. There may also be three or four idler wheels (one for each speed) between the motor shaft and the driver wheel. To reach these drive wheels, you must remove the turntable. Carefully



pry loose the “C” washer around the center spindle. Then gently lift the turntable up and off the spindle. On some changers, the spindle itself is removable.

A common complaint is incorrect speed — “wow” (uneven speed) or slow speed — or the changer stalling in its change cycle. This symptom is the fault of slippage in the drive wheels. The rubber drivers and idlers should be kept clean and free of oil. Remember: Never oil rubber drive wheels or idlers — not even their centers. Clean the rubber surfaces with alcohol. If a surface looks glazed, hold sandpaper lightly against it while the changer is running. If the drive wheel is in bad shape, have it replaced by a service technician.

The bearings in the motor itself may run dry enough to cause slow speed. A drop of light oil on top and bottom bearings will help, but don't overoil. Dirt may foul up the armature. The motor may need disassembly and cleaning, which is a job for a trained technician.

Another part you can check is the cartridge. This is the small object with the stylus (needle), which is mounted at the end of the tone arm. The most common cause of cartridge trouble is a worn or broken stylus. Use a magnifying glass to look at the stylus tip. It should be conical. If it isn't smooth and round, replace it.

You can disconnect the cartridge by carefully pulling the wires loose from the back end with a pair of tweezers. Before you do, sketch a diagram of the wire colors and how they're connected. Then, using a small screwdriver, remove the cartridge mounting screws. When you get the cartridge loose, take it to a radio-TV service shop, where you can buy a replacement stylus. They can also check the cartridge for you, to make sure it's okay.

On the tone arm, you'll also find some adjustments which must be set correctly for proper changer operation. Adjust needle pressure so the arm remains in the groove all through the record, and doesn't skip. (Be sure the turntable is level though, or this adjustment won't prevent the skipping.)

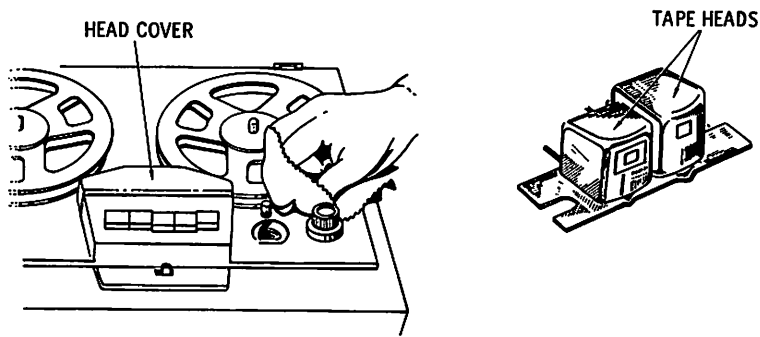
Adjust the tone-arm height, with the arm to one side of the record and turntable. The stylus should be able to set down slightly past the turntable surface.

Adjust the tone-arm landing so the stylus sets down in the lead-in grooves at the outer edge of the record, before the music grooves.

## Tape Recorders

Like phonographs, tape recorders should be serviced by trained technicians. But you can perform a few simple repairs and save yourself some money.

The oxide coating on magnetic tape wears off on the tape heads; dirt and grime in the air build up on these heads. In time, the heads become dirty and the tape recording sounds fuzzy. To clean the tape heads, use drug store alcohol and cotton swabs. You can also buy special heads cleaner at most radio-TV shops.



First, take off the head cover. It usually unclips or slips off, but sometimes you have to remove a couple of screws. Then wet a swab, without using too much liquid, and rub it across the heads. You'll see the swab turning brown or black, showing you've picked up some grime. Throw away the dirty swab and keep repeating until a fresh swab remains clean. You don't have to wipe the heads, because the alcohol evaporates quickly. Be very careful to touch the heads only with soft materials. Never use wood or metal near a head or you'll scratch and permanently damage it.

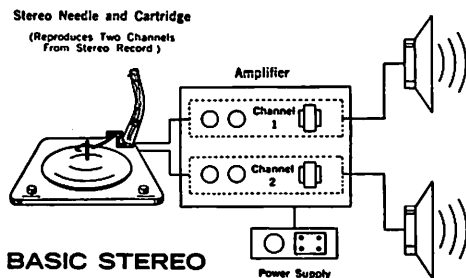
Watch the path the tape follows as it moves from one reel to the other. Then take out the tape and, again using swabs and alcohol, clean whatever idlers or arms the tape comes in contact with.

You can test tubes from tape recorders just as you do those from radios and TV's. You'll usually find a tube-layout chart inside the cabinet or pasted to its bottom. As always, be sure you get the tubes back in their proper sockets. Some modern tape recorders don't use tubes, but transistors instead. With those, consult your service technician.

## Stereo

Many people are confused about the phrases "hi-fi" and "stereo." Hi-fi means high fidelity, or good sound reproduction. Stereo means using two channels. Two microphones are used at the original recording session, and you listen to the music through two loudspeakers. For example, you may hear the violins from the left loudspeaker and the piano from the right loudspeaker. This produces a more realistic sound, because you get the impression that the orchestra is spread out across your living room.

Some people simply call a stereo phonograph a "stereo." The phonograph has two channels, one for each loudspeaker. The channels are called **left** and **right**. A typical tube layout is shown below.



You can frequently troubleshoot a stereo phonograph more easily than a standard (or mono) version, because of the two channels. If only one channel has the problem, and the other doesn't, simply swap the tubes from the good channel over into the bad, one at a time. If the trouble shifts to the other channel, you know the tube you've swapped is bad.

You can also discover a defective cartridge the same way. First sketch a diagram showing which color of wire goes to each terminal, so you can put them back the same way. Then, reverse the cartridge leads. If the trouble shifts to the other channel, the cartridge is probably faulty.

Some tape recorders are also stereo. They have two channels, and you can test them as you would a stereo phonograph, interchanging tubes from one channel to the other. Many recent models, however, use transistors.

The newest type of stereo is stereo FM. The listener with any kind of FM set receives a complete program from a stereo FM station. But the stereo information is carried on a special subchannel which ordinary FM sets can't use. If you have a stereo FM set, you receive a two-channel program. There are a few more tubes in the stereo FM set, and sometimes they are very critical. You may have to test some of them by substituting a new tube for a suspected bad one.



## **In Summary**

After installing a new tube, some people put the old one back in, just to see if it will work. Sometimes the set works okay—or seems to. Maybe you've tried this and felt cheated. You thought you wasted your money. Don't worry—you didn't.

A weak tube may work in a set, but it puts the set on the verge of breaking down. And when it does break down, sometimes other tubes or even capacitors or resistors also break down as a result. You end up with a major trouble on your hands—one you can't fix yourself. Then you have to call a service technician to cure the problem.

As soon as you find a weak tube, replace it. You'll prevent future trouble and save yourself costly repairs. Tubes last anywhere from 2,000 to 10,000 working hours, and there's no way to predict how long one particular tube will last. The best thing you can do is test the tubes in your radios, TV sets, record players, etc., at periodic intervals—say, every six months. Replace any that test weak or bad.

A word about service technicians. Most are honest and reliable. A few, of course, are bad eggs, just as there are unreliable workers in every trade and profession.

Use this booklet to troubleshoot your own radio and TV sets. When you find a trouble you can't fix, which won't be often, call a service technician. Best bet is to talk to your neighbors and find out what they think of the shops in your area. Honest, competent TV and radio technicians maintain a good reputation among their regular customers, and that's a gold-plated recommendation.

When you find a good one, be sure to tell him exactly what you've done in testing tubes or other repairs. He'll appreciate knowing the history of your set, and it will help him sort out the troubles. It will also keep the size of your bill down.

**Good troubleshooting!**

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