POPULAR MECHANICS

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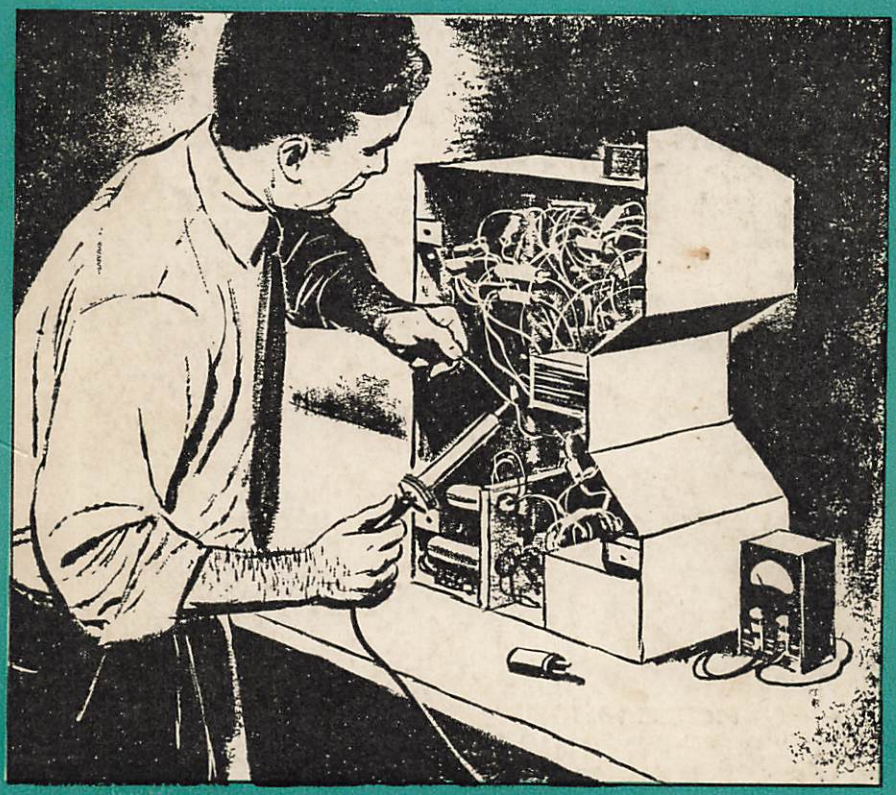
DO-IT-YOURSELF BOOKLET NO. 14

SIMPLE TELEVISION REPAIRS



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Do-It-Yourself Booklet No. 14

Simple TELEVISION Repairs

Popular Mechanics Press

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CHICAGO 11, ILLINOIS

Printed in U.S.A.

INSIDE YOUR TV SET

TELEVISION installation and service were for a long time considered as things to be attempted only by the skilled technician. And, for a shorter period of time, many dealers regarded the installation of a television receiver they sold as a prerogative they should insist upon in order to make sure that the set operated satisfactorily and the customer was pleased by the service rendered.

Now, however, the picture has altered considerably. More and more television sets are sold at low cost, which leaves the dealer with no margin to use for such services as free installation and checkups.

After a few hardy souls showed the way, the erection of television antennas by rank amateurs became common. More recently, many set owners have undertaken to save themselves the relatively high costs of servicing. Some are successful, and some are not.

There is no reason why any television owner cannot perform many, if not most, service and replacement needs on his set. However, in order to do anything successfully, it is very desirable to know just a little bit about *what* you are doing. In this chapter the television receiver in general—and no one make or model in particular—is described by sections so that you can perform various operations on your receiver and know to some extent *what* you are doing and *why*.

There are a number of reasons why home television service is quite practical. Most important is the fact that the greatest majority of difficulties arise from the simple failure of one or more of the small vacuum tubes. Certain of these tubes cause definite effects on the face of the tube when they fail. Thus, by noting what the picture is—or is not—doing, the owner can determine the part of the circuit in which the trouble lies. Once this is determined, the simplest way to correct the trouble is to replace the defective part.

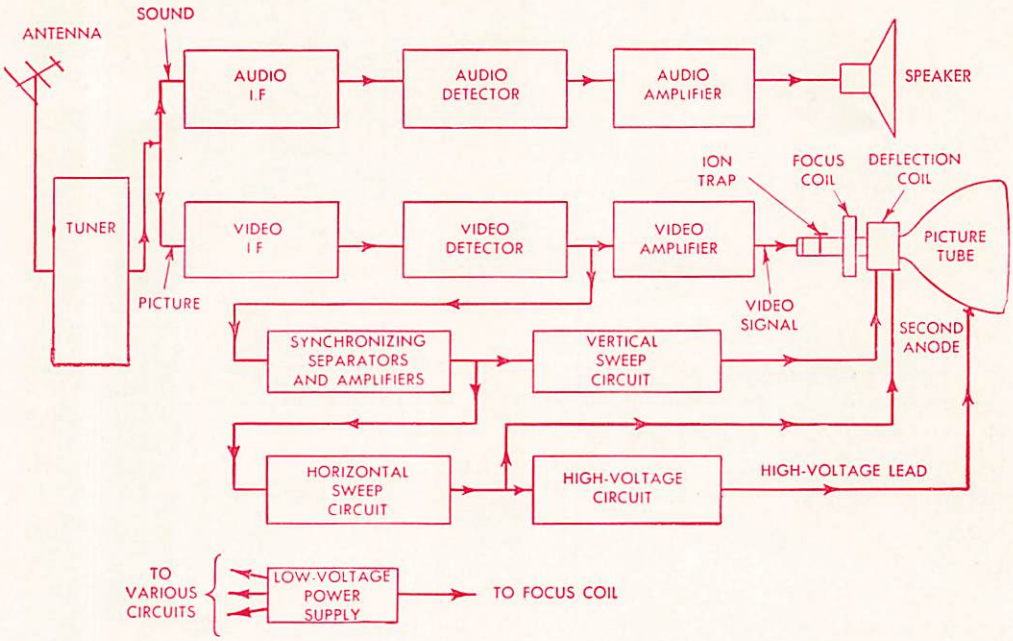
Know Your Circuit Layout

A block diagram of a typical television receiver is shown. This diagram is not of any one set, but a composite which shows the basic circuits, their functions and their relationship to other circuits and parts of the set.

Most television manufacturers have laid out diagrams for their particular sets for the convenience of servicemen. It may be possible for you to obtain one of these from the manufacturer of your set or from a dealer.

On the back of your receiver you will find a perforated cover. This cover is there to seal in the extremely high voltages present inside, and is perforated to provide ventilation for the heat generated in the set. A plug on the cover in turn plugs into a two-prong socket in the set. When the cover is removed, the circuit is broken

BLOCK DIAGRAM OF TYPICAL TV RECEIVER



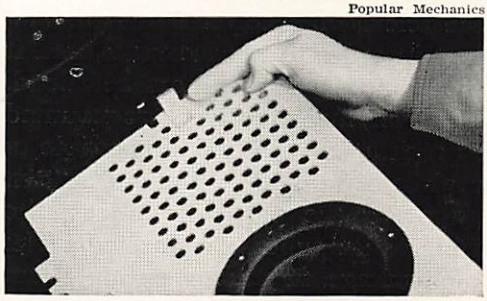
and the receiver cannot be turned on. This device is called a "safety interlock."

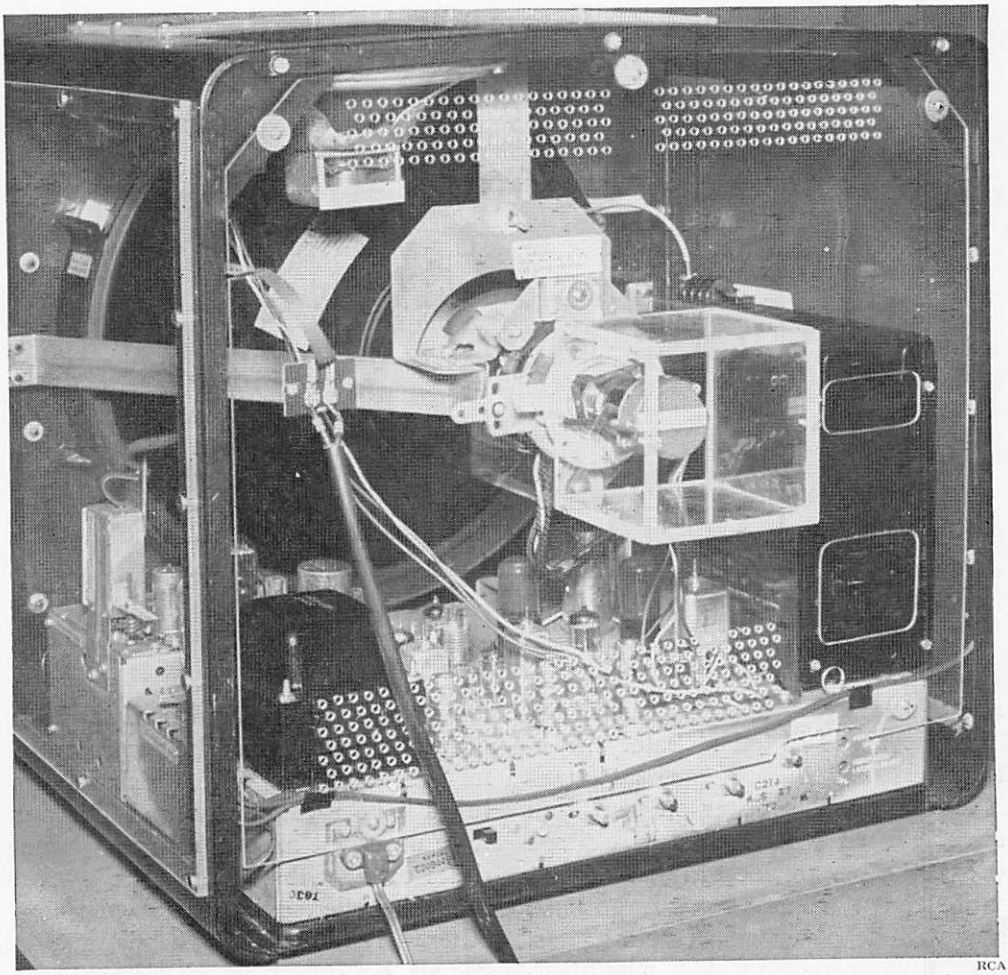
Never take this cover off until you have learned where the high-voltage danger points are located and how to avoid them. This is most important, and will be discussed in detail later. The high voltage in even a small 7-inch receiver is as great as 4500 volts, while the projection-type receiver found in most homes will go as high—and sometimes higher — than 27,000 volts! Voltages of these strengths should be treated with respect.

The parts that make up a television receiver — tubes, resistors, condensers, coils, wiring and sockets—are mounted on a metal base called the chassis. In some receivers all the parts, including the picture tube and the speaker, are mounted on one chassis. In others, the speaker has its own chassis; still others have the picture tube mounted separately, and some have different circuits mounted on individual chassis. It is quite common to find the power transformer, rectifier tube, high-voltage tubes and transformer and damper tube mounted on one chassis — sometimes called the "power deck" — and the rest of the receiver mounted on another. In such cases the chassis are connected by cables which either join each other or plug into sockets mounted on the chassis themselves. In order to remove the receiver from the cab-

This is the safety interlock that cuts off the power when the back of the TV-receiver cabinet is removed

Popular Mechanics





RCA

Housed in clear plastic, this set shows mounting of tubes and parts

inet, it is often necessary to disconnect these cables. Before doing so, it is wise to mark each one and the socket into which it plugs so that the parts can be reassembled correctly.

It is not always necessary to remove the television receiver from the cabinet in order to replace tubes, and it should not be done if it can be helped. However, many receivers are mounted in such a way that it is impossible to replace certain tubes without at least removing the particular chassis to which that tube is connected. The high-voltage tubes, for example, are usually enclosed by a metal shield which must be uncovered or removed before the tube can be replaced. Also, some of the miniature tubes used are located in such a position that more time is wasted trying to fit the tube prongs blindly than would be spent in removing and replacing the chassis.

Removing the Chassis

Certain definite steps should be followed when the television receiver is removed from the cabinet. These steps are enumerated here; if carefully followed there will be no shock hazard:

1. Turn off the set and pull the power cord out of the wall receptacle.
2. Remove the knobs from the front controls. These knobs generally are of the push-on type and can be removed quite easily. This must be done so that the shafts of the controls can be drawn through the holes in the front panel. Any special tools required to loosen set screws can be obtained cheaply at any radio-supply house.
3. Remove the back shield, which usually has the safety interlock riveted to it. This exposes the receiver and also completely disconnects the source of power. In some cases it will be necessary to disconnect the antenna before removing the back cover. Inasmuch as some receivers have antenna connections for either 300-ohm or 72-ohm lead-ins, it is wise to make sure which one is being used before disconnecting any antenna lead.
4. Carefully inspect the chassis and determine how it is mounted. Usually they are held by bolts, fed through a wooden base or mounting, which screw into the corners of the metal chassis. In some receivers, ordinary wood screws are used. These bolts or screws should now be removed.
5. Check the speaker mounting and connection. Unless the speaker is mounted directly on the speaker chassis, it must be disconnected. Various forms of connections are used: Some speaker leads plug into a socket on the chassis, others plug into one end of a cable leading from a chassis.
6. Inspect the picture tube to see if it is mounted independently of any chassis or if it is mounted on the same chassis that holds the other parts of the receiver. If mounted independently, it must be disconnected in the same manner as the speaker. If this is necessary, more steps must be taken at this point. The high-voltage lead which plugs into the side of the tube should first be disconnected and grounded to one of the chassis. An illustration on page 28 shows how this is done. Be very careful not to touch the metal tip of the lead, as there is enough charge in the high-voltage condensers to give you quite a "nip." Grasp the lead firmly at the base of the rubber suction cup when handling the lead and disconnecting it. Next, disconnect any other cables which connect the picture-tube unit to the other chassis. The parts around the neck of the picture tube, with the exception of the ion trap, are fixed firmly and should not be removed when taking out the receiver. The tube socket is taken off. This socket is "keyed" to fit on the tube base only one way, so you need not worry about getting it back incorrectly. As a further precaution against shock, it would be wise at this time to short-circuit the high-voltage coating on the picture tube by placing a length of insulated wire between coating and chassis.
7. If the chassis in the receiver are all separately mounted, they should be disconnected at this time.
8. The receiver is now ready for removal. This should be done carefully and gently—first to make sure it has been disconnected properly, and secondly because the receiver is a fairly delicate instrument that cannot take too much bouncing and bumping.
9. Carefully reassemble the receiver. Be sure that all connections are together firmly and that a good contact is made. This applies especially to the high-voltage lead attached to the second anode on the side of the tube.
10. Inasmuch as the power cord and its safety plug are riveted to the perforated back cover of the set, it will be necessary to buy an extra one to operate the receiver while it is out of the cabinet. These can be obtained at any radio-supply house for less than a dollar.

Tuner Adjustment

The tuners of television receivers are all carefully adjusted before the sets are shipped from the factory. The tuning adjustments made on them are critical in the highest degree. Unless he is very well equipped with test instruments, even an experienced serviceman will make no attempt to adjust the tuning of this circuit because of its delicate balance.

There are but two repairs the home owner should attempt on the tuner section of his receiver. One is the replacement of defective tubes. The second is adjustment of the oscillator. The first is simply a matter of pulling out the defective tube and inserting a new one.

With few exceptions — notably the continuous-type tuners — the tuners used in television receivers have fine-tuning controls. These usually are found at the front end of the tuner-assembly shaft. The purpose is to enable the owner to tune sharply the station he selects. In this way he can compensate for changes in the values of condensers and resistors because of age or other factors, all of which alter the tuning of the receiver.

At times, however, no matter how the fine tuning is adjusted, the picture cannot be brought in clearly with good detail and contrast. Or, what is worse to some people, the sound and picture are not synchronized. Tuning in a good picture results in poor sound, and vice versa. Any of these can occur when the oscillator or mixer tubes are changed. The difficulty may show up gradually, indicating such wide changes in circuit component values that the fine-tuning control is no longer able to compensate. Under these circumstances, it is possible that the oscillator can be adjusted to correct these troubles.

Oscillator Correction

Oscillators generally are tuned by varying the depth to which a brass or iron core is inserted in the hollow center of a coil.

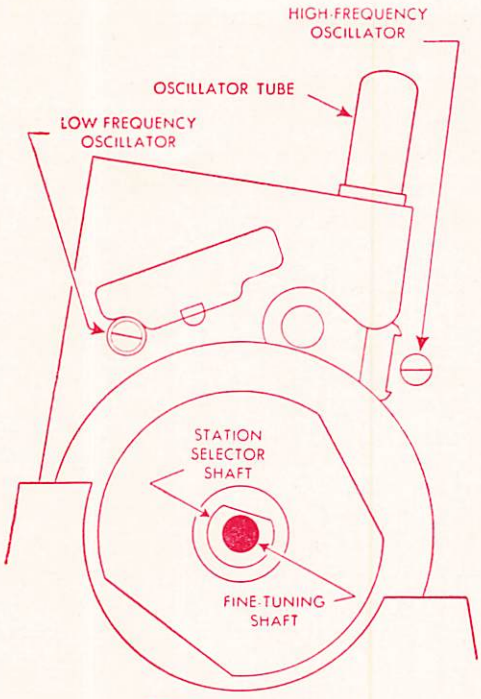
Inserted in the coil is a threaded brass slug with a screwdriver slot at the outer end. When the channel strip is inserted in the tuner, this slotted end can be seen through the hole in the tuner marked "H." The oscillator is adjusted while the set is tuned to the defective channel.

Because of the frequencies involved in radio and television, tuning any section which operates at radio frequency must be done with a nonconducting screwdriver. These can easily be purchased for a small sum, or it is quite easy to make one from a slender piece of wood. With such a tool, turn the slug in the oscillator coil slowly and carefully. Watch the picture and listen to the sound with equal attention. There will be a point at which both picture and sound are at their best. If this point gives satisfactory results, no further adjustment is necessary.

If the results still are unsatisfactory, the oscillator tube should be changed and a new one tried. If the trouble lies in the oscillator section because of mistuning or a defective oscillator tube, this adjustment will clarify the picture and give good, synchronized sound.

In the turret-type tuner there is a separate oscillator adjustment for each channel. The process outlined should be performed only for those which may be defective. The procedure, however, varies somewhat in tuners which do not have separate strips for each channel.

As a general rule, the adjustment



FRONT VIEW OF TUNER

for the oscillator is found on the front end of the tuner. One type of tuner has only two oscillator adjustments, one for Channels 2 through 6 and the other for Channels 7 through 13. These are referred to as the "low-frequency oscillator" and the "high-frequency oscillator." Because of the variety of tuners used, it is impractical to show details of every type. For the location of oscillator-tuning adjustments, it is necessary to refer to the service diagram of your particular set.

An example of a switch-type tuner is shown. Notice the two screwdriver adjustments for oscillator tuning. In making adjustments for the low-frequency channels, any station in that band is selected and tuned in as best possible. The oscillator is then adjusted for picture and sound. The channel selector is then turned to another station in the low-frequency band and the same procedure is followed, using the same oscillator-adjusting screw. Then return to the first channel. If the fine-tuning control cannot be adjusted to bring in the proper picture and sound, the oscillator slug should be retuned. Return to the second station and check. It may be necessary to repeat this procedure several times before settling on one position that satisfies the requirements of all the stations involved.

The steps to be followed in adjusting the oscillator for the high-frequency band are the same. Because of the higher frequencies, be more cautious in turning the slug.

Certain types of receiver employ a type of tuner which has replaceable channel strips other than those mentioned and illustrated. In these, it is frequently possible to purchase from the manufacturer a replacement part for an offending channel. This is necessary in those cases where there is no doubt that the strip itself is defective. Normally this is a task for a serviceman, but in localities where none is available the job can be done by a handyman.

Primary Controls

The primary controls of a television receiver are generally located at the front of the cabinet. These are the operating controls. They are:

Station or channel selector. By this means the station desired is selected. It controls the action of the tuner by putting into the circuit the proper r.f. amplifier circuit and oscillator circuit. As described previously in explaining the action of the tuner, the parts making up these circuits often change in value or adjustment. It is necessary to have some means of compensating for these changes. This is a function of the

Fine-tuning control. As a rule, the fine-tuning control and the channel selector are mounted on concentric shafts—that is, the shaft of the fine-tuning control is within that of the selector shaft. After the station desired is selected, it is brought into sharp detail by the fine-tuning control. This control is not found on continuous-type tuners.

Volume control. This performs the same function in a television receiver as the volume control of a radio — it controls the amplitude level of the sound.

Brightness control. This governs the brilliance of the screen image. When the brightness control is varied, the difference in voltage between the grid and cathode of the picture tube is changed.

Contrast control. This governs the "volume" of the picture in much the same way as the volume control governs sound. In most sets the contrast control regulates the video i.f. stages; in others it controls the video amplifiers and occasionally it also controls the r.f. amplifier.

Vertical hold. Occasionally called the frame control or vertical-frequency control, the vertical hold keeps the vertical-sweep circuits operating at 60 cycles per second. The same comments that apply to the vertical hold are true of the horizontal hold. Often, the two controls are mounted concentrically. Like the horizontal hold, the vertical hold is sometimes mounted at the rear.

Horizontal hold. This is sometimes called the horizontal synchronizer, the synchrolock and the speed control.

Secondary Controls

Secondary, or nonoperating controls, are those which seldom need adjustment. They are usually mounted at the rear of the set or under a plate on the front panel.

Focus. The focus control is a current-regulating device. Varying the current passing through the focus coil changes the focal length of the electronic lens set up by the magnetic field. The focus control should be adjusted for the sharpest lines on the screen. This, like all image adjustments, should be done when the test pattern is being broadcast. One adjustment will satisfy focus requirements for all channels.

Width. This control is a coil or condenser which varies the operation of the secondary winding of the high-voltage transformer. Varying this control requires a screwdriver. Some require many turns before any effect can be noticed on the picture. Others can be turned only one revolution in all.

Horizontal linearity. This control makes sure that the voltage applied to the horizontal-deflection coil is smooth and even. If it is jerky, the picture will appear pulled in or pushed in on one side or the other. Like all secondary controls, adjustment is to be made slowly and carefully.

Vertical linearity. Similar in appearance and action to the horizontal-linearity control, the vertical-linearity control is used primarily to correct distortion in the top half of the picture. It acts on the vertical-sweep circuit and its frequency of 60 cycles.

Height. Distortion of the lower half of the picture is corrected by the height control. It is almost always necessary to adjust the height and vertical-linearity controls together. Should it be necessary to adjust either one, only do so to fill the screen. Do not attempt to center the picture by these controls.

MERIT TRANSFORMER CORPORATION

MANUFACTURER OF SET AND MODEL NUMBER	POWER TRANS.		HOR. OUTPUT		VERT. OUTPUT		VERT. BLK. OSC. BLK.	
	MFG. PART NO.	MERIT PART NO.	MFG. PART NO.	MERIT PART NO.	MFG. PART NO.	MERIT PART NO.	MFG. PART NO.	MERIT PART NO.
RCA—(Continued) (Ch.KCS24B-1-C-1,KRK1A,KRK4, KRS20A1-B-1,KRS21A-1)	72177	P-3063			72952	A-3035	71775	A-4000
8T241-3-4,8TV321-B, 8TV323-B,9T240-6, 9TC240,9TV333(Ch.KCS28-A-B-C-30-1)	73567 73601	P-3063 P-29524	73570	HVO-3	73568	A-3035	73569	A-40001
8T270,8TC270-1, 8TX320,9T270, 9TC272-5(Chassis KCS29A-C,KCS33A-1)	74143	P-3061	74145	HVO-5	73568	A-3035	74144	A-40001
8TX29,8TV29(Chassis 32-A-B-C)	74046	P-3063	73570	HVO-3	73568	A-3035	73569	A-40001
9T57,9T77-9,9T89(Chassis KCS49-A-AT-1,KCS60-A-AT-1)	75508	P-3059	75585	HVO-8			74144	A-40001
630TCS,630T8,8T830 (Chassis KCS-20A-1,20B-1,20J-1)	71415	P-3061	71416	HVO-3	71417	A-3035	71418	A-4000
721TCS,730TV1,730TV2 (Chassis KCS27-1-2)	71772 71875	P-3059 P-29511	71416	HVO-3	71774	A-3035	71775	A-4000
RADIO CRAFTSMEN RC100			19X006	HVO-6	19S007	A-3037	19S601	A-30001
RC100A			19X010	HVO-6	19S009	A-3036	19S601	A-30001
RC200								

You will need to become familiar with parts catalogues like this one

Horizontal drive. This control regulates the amplitude of the pulse fed to the horizontal-amplifier tube and thus affects the high voltage to some extent. Any adjustment of this control will also have an effect on the horizontal linearity, width and occasionally the horizontal hold, so that these adjustments may have to be "touched up" after changing the horizontal drive.

Horizontal and vertical centering. These controls vary the current flowing through the deflection coils. They are not found on all receivers. Those which do not have such controls center the picture by the positioning of the focus coil around the neck of the picture tube. This is adjusted by means of a shaft which protrudes through the perforated back cover of the receiver.

In receivers which have a rotary vertical-centering control, this is remedied simply by rotating the control until the picture is centered. (At no time should the picture or test pattern be centered either horizontally or vertically by using the height, width or linearity controls.)

TV-Circuit Tubes

Although many different tubes are used in the various makes of receivers, there are some which are commonly used in all types. It will be helpful in servicing your own set to have an idea of the tubes most commonly found in the various circuits. A survey has shown the following chief types:

Tuner—6J6, 6CB6, 6AG5, 6AK5, 6BC5, 6AB4
Sound i.f.—6BA6, 6AU6, 6SK7
Audio amplifier—6AU6, 6V6, 6K6, 6L6, 6SJ7, 6S8GT
Audio detector—6AL5
Video i.f.—6AU6, 6AG5, 6CB6, 6BA6
Video detector—6AL5
Video amplifiers—6AU6, 6AC7, 6SH7, 12AU7, 6AQ5, 6V6
Vertical sweep—6SN7, 12BH7, 12SN7, 6SL7, 6V6, 12SL7
Horizontal sweep—Same as vertical sweep, above
Synchronizing circuits—12AU7, 6SL7, 6SN7, 6AL5
Low-voltage power supply—5Y3, 5U4G, 5V4, 6X5
High-voltage power supply—1B3, 1X2, 2V3, 6BG6, 6BQ6, 6CD6

Danger Points

Now that the functions of the receiver have been explained and the common tubes listed, a study of those points which contain shock or mechanical danger can be made.

There is only one source of mechanical danger in a television receiver—

the picture tube. The inside of the tube is maintained at a high vacuum. If it should break, air would rush in to cause an "implosion," and glass would fly all over the immediate area. For this reason you are advised to wear leather gloves and safety goggles when handling the picture tube.

There are real electrical hazards present in a television set. If the proper precautions are observed, however, there is no danger at all. The ones who get hurt are those who are careless or who didn't know the set was "loaded."

After a receiver has been turned on, a charge is built up in the many condensers which lingers long after the power is turned off. To prevent shocks during repair, this voltage should be discharged, or "bled." The metal chassis offers good discharge points.

In discharging the high-voltage lead to the second anode of the picture tube, grasp the lead firmly by the rubber cap that surrounds the contact point and break the connection. Discharge, or "bleed off," the electrical energy remaining by touching the metal tip of the lead to some portion of the chassis. Frequently there will be an arc at the point of contact. This is caused by the stored energy jumping over the gap to the grounding point. When this arcing stops, the charge is fully dissipated and the contact of the lead is safe to touch.

The picture tube itself, if of the glass envelope type, has a coating on the outer surface. Called the "dag," this coating often holds a charge which, though slight, should be discharged. If it is not you might get enough of a jolt to drop the tube. Any piece of insulated wire will serve as a medium for discharging this and the other storage points in the set.

How to Make a Shorting Tool

For the amateur repairman, an 18-inch length of ordinary lamp cord can be made into a satisfactory shorting, or discharging, device. Bare both ends of the wire and twist together the two conductors at each end. A half inch of bared wire is sufficient. If a soldering iron is available, it is wise to solder the bared ends to prevent fraying of the strands and to give the ends stiffness. Next, take two short pieces of wood, about 4 inches long, and tape them at each end of the rubber-covered section, leaving the bare wire protrude. This will provide a handle at each end.

To use this shorting tool, touch one end to the part that is to be discharged and the other end to the chassis. This provides a free path for the electricity to flow out. Sparking will result when this is done, but this is harmless and need not cause you concern.

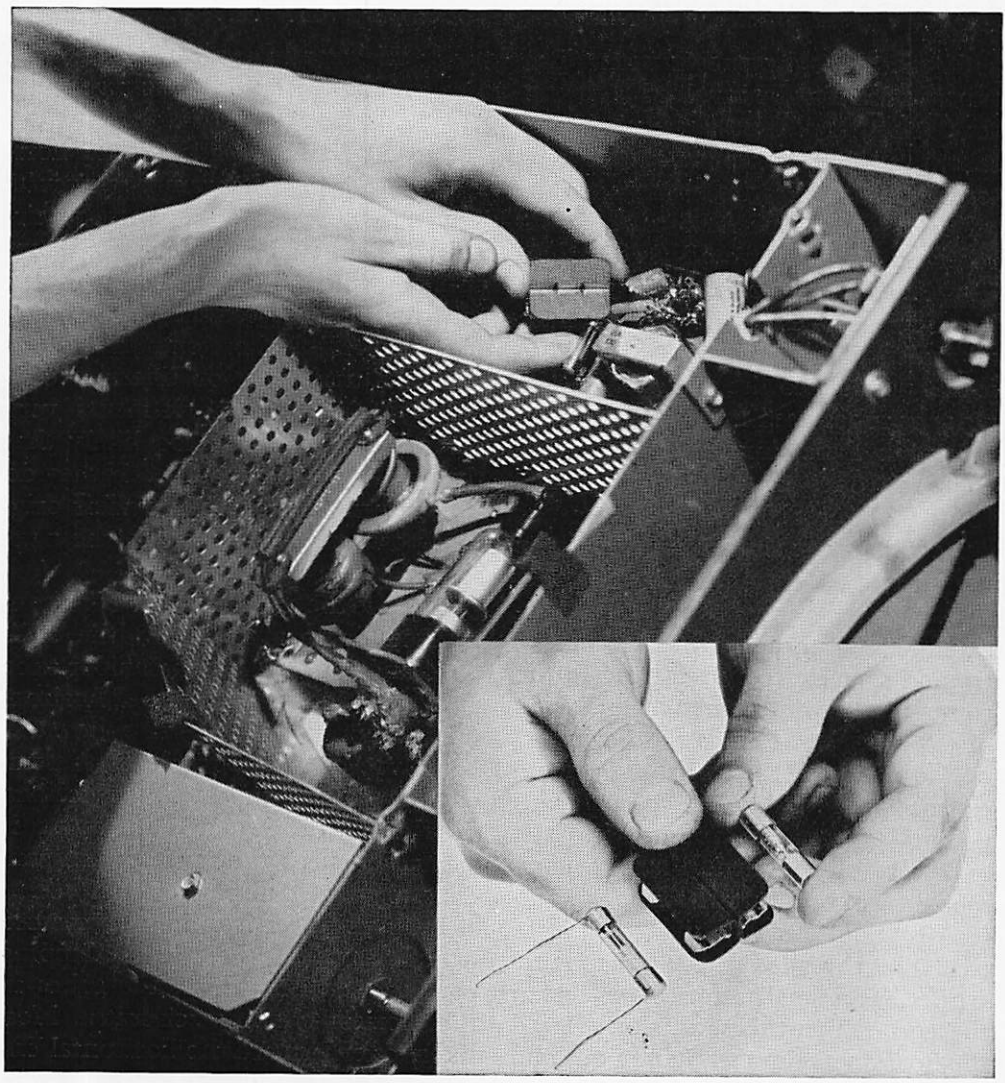
Remember to keep your fingers well back of the bare ends of the shorting wires and do not permit any part of your body to touch the receiver. Amateurs are not likely to be careless when performing this operation the first few times. But the point to remember is that care must always be exercised even after you have become so adept at the shorting-out process that little thought is given to it. *Do not let familiarity breed contempt.*

How to "Bleed" a Set

The danger points commonly found and the procedure to be followed in discharging them are as follow:

1. High-voltage lead from power supply to picture tube. Remove and short the metal tip against the chassis. An arc will result. Be careful to grasp the lead by the rubber cap and do not let your free hand touch any part of the receiver. Follow the electrician's adage: "Keep your free hand in your hip pocket."
2. Short the cap connections to the high-voltage rectifiers and amplifier tubes to the chassis. This requires removing the cover of the high-voltage supply.
3. Short the outer coating of glass picture tubes to the chassis. Metal tubes are covered by a plastic insulating jacket. Stick an end of the shorting lead under this jacket, make contact with the tube envelope and short to the chassis.
4. If the underside of the chassis is going to be handled, it will be wise to short the positive leads of the filter condensers.

Snap-on fuse holder. Inset photo shows how easily replacement is made



The remainder of this booklet is devoted to common television troubles, their causes and their cures.

Horizontal Bars Across Screen (Loss of Horizontal Synchronization)

Causes — Misadjusted horizontal-hold control, misadjusted horizontal-oscillator transformer, defective horizontal-oscillator transformer, defective horizontal sync-circuit tubes, defective resistors or condensers in the circuits.

Cures—Readjust the horizontal-hold control.

Check tubes by substitution. The tubes which may be involved here are: the horizontal-oscillator tube, horizontal-sync clipper, horizontal-sync separator, horizontal discriminator, horizontal discharge or the AFC tube. Most receivers do not have all these tubes. They are listed here to help the owner identify the ones in his own receiver regardless of how they are labeled. It is not possible to list all the different types of tubes used in all makes of receivers in these circuits, but the most common ones are: 6SN7, 12AU7, 6SL7, 6AL5, 12SN7, 12SL7.

Readjust the horizontal-oscillator transformer. This unit is on the main chassis of the receiver and can be located by reference to the service bulletin and sometimes by referring to the component-layout chart on the inside of the cabinet. This is the device by means of which the horizontal-sweep-circuit frequency is put in step with the pulses from the transmitter. It is generally "slug" tuned. The most common type of horizontal-oscillator transformer is quite easily adjusted. Notice that the threaded shaft which protrudes has a small screwdriver slot at the end. Turn this shaft slowly until the horizontal lines straighten out and the picture appears clear. This should be done with the horizontal-hold control centered, so that after the adjustment has been made on the transformer there is play on either side of the hold control. This is a primary control, and the play is needed for making small adjustments.

Replacement of resistors or condensers will usually require the services of a technician unless you have had radio-repair experience and own an ohmmeter for testing.

Horizontal Overlapping (Picture Folds Over on Itself from Side)

Causes—Defect either in the horizontal-sweep circuits, damping circuits or possibly the sawtooth generator circuits. Slight change in values of components which may be compensated for by adjusting secondary controls.

Cures—Adjust horizontal-hold control. Adjust width or linearity controls. Make these adjustments very carefully as it is not too likely that they will cure this trouble. If they do not, return the controls to their original positions and go on to the next step.

Replace the damper tube. Commonly used damper tubes are the 5V4, 6W4 and 6AS7. A weak damper tube is the most common cause of horizontal overlapping.

Failure of the above cures to remedy the trouble indicates a serviceman should be called. If equipment is available, check the resistors and condensers in the damping circuit.

If the foldover is quite pronounced — both sides of the picture lapping over the center — check the tubes in the horizontal-sweep circuits. Most likely offenders are the horizontal dis-

charge, horizontal output, horizontal-amplifier tubes. 12AU7, 6BD5, 6BQ6, 6BG6 are commonly used types.

Wrinkled Edge on the Picture

Causes — Defective damping tube, defective deflection yoke or components in the deflection circuits.

Cures — Although it is very seldom that a defective damping tube will cause wrinkles, it is the simplest thing to replace for this defect and should be tried first. Common types are 5V4, 6W4 and 6AS7.

The deflection yoke has a number of small components — resistors and condensers—mounted on it. Some of these may be at fault in this case and should be replaced.

The deflection yoke itself will sometimes cause wrinkles. Because there is small likelihood of these yokes going bad, it is not worth while to keep one on hand to check the old one by the substitution method. If an ohmmeter or other test instruments are readily available, resistances and voltages can be checked. The man handy with a soldering iron can replace the small components attached to the deflection yoke at small cost. For component values, refer to the service bulletin.

In doing repair work of the above-mentioned type, the amateur repairman can be quite successful if he is careful to replace components with others of the exact value required, if he labels his wires so that they can be reconnected to the proper terminals and if he makes sure that all solder joints are firm and properly made. All power should be turned off and condensers and other danger spots discharged, of course, before proceeding with work of this sort.

Vertical Line on Screen

Causes — Failure in the horizontal-sweep circuits. (NOTE—This trouble occurs only on receivers whose horizontal-sweep circuits and high-voltage circuits operate independently of each other.)

Cures—Check tubes in the horizontal-sweep circuits. Most likely offenders are the horizontal-oscillator and the horizontal-output or amplifier tubes (12AU7, 6SN7, 12SN7, 6BD5, 6BG6, 6BQ6). In 7-inch receivers, it will almost always be found that this difficulty is caused by a defective 12-SN7 tube.

Occasionally a receiver has a small fuse on the order of ¼-ampere in this circuit. If that opens, the result will be a vertical line. If the horizontal-deflection coil in the deflection yoke opens, there will be no horizontal control applied to the electron scanning beam. If an ohmmeter is available, this can be checked.

Narrow Picture; Cannot Be Widened To Fill Screen

Causes—Defect in the horizontal-sweep circuits or in the low-voltage power supply.

Cures—Although the apparently logical first step is to check the tubes in the horizontal circuits, this is one defect which does not quite conform to the logical way of servicing as the most common cause of a long, narrow picture is weakening of the low-voltage power-supply rectifier tube. As a general rule, the narrowing comes about rather gradually. The first step, then is to substitute in the low-voltage power supply. The most common tube in this circuit is a 5U4G. 5V4G tubes are

occasionally used, as well as 5Y3 tubes. In the latter case, two or more are often found instead of one single tube as the 5Y3 is not capable of performing as much work as either of the other two types. As this power supply also affects the other tubes in the set which receive and amplify the signals, it will usually be noticed that the overall performance is improved in replacing a defective one.

If, after trying the low voltage rectifier tube, the picture still is too narrow and cannot be widened with the width control, substitute the horizontal-oscillator and amplifier tubes. The horizontal-output or amplifier tube is, incidentally, the most expensive one in the receiver excepting the picture tube. In replacing any of the tubes in the horizontal-sweep circuits, it should be borne in mind that it is almost always necessary to make a readjustment of the horizontal secondary controls—width, speed, frequency, hold and the like. These adjustments should not be made, of course, until the trouble has been cured. Generally speaking, the horizontal-oscillator transformer is that which will require the adjustment so that it can bring the horizontal-sweep frequency in step properly by taking into consideration the changed characteristics of a new tube.

Failure of certain other components will also cause a long, narrow picture. A shorted horizontal-deflection coil, shorted output transformer, and defective condensers and resistors are possible causes.

Scalloped Edges on Picture

Causes—Defective filtering in the sweep circuits.

Cures—This is a rather difficult trouble to cure without proper equipment. It usually occurs in the vertical circuit and indicates that a ripple from the 60-cycle components is getting through due to failure or leakage of a filter or by-pass condenser in the sweep circuits. Unless one has testing equipment available, it is necessary to call a serviceman. If equipment is handy, check the by-passes in the centering circuits and the filtering condensers in both sweep circuits. The same effect can be brought about by defective filter condensers in the power supply.

Picture Split by Vertical Black Line With Portion of Picture On Each Side of Bar

Causes — Defective horizontal discriminator or sweep circuits.

Cures—Adjust discriminator or oscillator transformers in horizontal-sweep circuits. As previously mentioned, these transformers are usually the slug-tuned type with a threaded screw for control.

Defective discriminator tube (6AL5).

Analysis of this trouble will logically lead to the conclusion that the horizontal-sweep frequency is twice what it should be so that two pictures instead of one appear.

Picture Rolls Vertically (Loss of Vertical Sync)

Causes — Poorly adjusted vertical-hold control, defective tubes in vertical-sweep circuits, defective small components in vertical circuits.

Cures—Adjust vertical-hold control. This is best done by rotating the control until the picture moves downward very slowly. Then reverse the rotation to the point where the picture snaps back into a steady position.

Replace tubes in the vertical-sweep section. These include the vertical-synchronization tubes, both clippers and separators. Types used are 12AX7, 12AU7, 6SN7, 12SN7 and 6J5 tubes.

Failure to correct this defect either by adjustment of the hold control or substitution of tubes in these circuits is evidence of the failure of a small component. This is best repaired by a serviceman. As always, any replacement of small components should be attempted only by those with some knowledge of radio repair.

Horizontal Line in Center of Screen (No Vertical Sweep)

Cause—Vertical-sweep circuits have developed failure.

Cures—Replace vertical-oscillator or amplifier tubes. The common ones used are 6AQ5, 6SN7, 12BH7, 12SL7, 12SN7, 6V6, 7C5.

Check the vertical-linearity and height controls by moving them slightly while observing the picture. These are usually carbon potentiometers, and over a period of time arcing can occur which will burn a small spot at the point of contact and break the circuit. If this does happen, it is sometimes possible to clean the offending component by pouring into it some carbon tetrachloride, which washes out the grit. At other times, slightly moving the control contact off the bad spot will bring back the vertical sweep with a slight sacrifice to height or linearity.

The best cure, of course, is to replace the control that has gone bad. This is very simply done if one has available the direct replacement, pliers and a soldering iron and is careful to install the new unit in exactly the same way as the old one.

If tube replacement does not cure the trouble and the height and vertical-linearity controls are good, any further repairs should be attempted only if one has an ohmmeter for testing. If an ohmmeter is available, continuity should be checked on the vertical-blocking transformer, the vertical-oscillator transformer and the vertical-deflection coils in the deflection yoke. Open resistors and shorted condensers in the vertical-amplifier circuits can be at fault.

Picture Too Large or Too Small Vertically

Causes—Vertical-sweep circuits, vertical-linearity and height controls, voltages to vertical circuits not proper.

Cures—Adjust height and vertical-linearity controls.

Replace vertical oscillator and/or amplifier tubes.

Check small components in this circuit.

Check voltages applied to vertical-oscillator and amplifier tubes to see if they meet the standards set by the manufacturer in his service bulletin. If not, the supply voltage should be traced back to the source to see where the trouble lies.

Top and Bottom of Picture Out of Proportion

Causes—Linearity and height controls misadjusted, defective vertical-amplifier tube, defective components in the vertical-oscillator and vertical-amplifier circuits.

Cures—Readjust the vertical-linearity and height controls.

Replace the vertical-amplifier tube —6SN7, 6AQ5, 6J5, 12AT7.

Check small components with an ohmmeter.

Picture Jumps Vertically Up or Down

Causes—Vertical-hold control set too critically, vertical-sync circuits not operating properly, poor filtering, interference entering through antenna.

Cures—Reset vertical-hold control. Picture should snap in position with a good, positive action. If not, trouble lies elsewhere.

Replace vertical-sync-circuit tubes—sync clipper, sync separator, etc. Checking the filtering usually incurs a fair amount of signal tracing to find where alternating current may be entering the circuit and is usually a job for the professional serviceman.

If the trouble is caused by interference which enters through the antenna system, as would be the case where ignition noises and other electrical interference is the cause, only two real cures are available—reorienting the antenna for minimum interference and replacing the lead-in with a coaxial or shielded type. Of course, it is possible to trace down the source of interference and shield it, but that is often quite difficult to do and even after the cause is found it may not be possible to cure it.

Occasionally, microphonic tubes will cause the picture to be jumpy. Tap the tubes in the vertical circuits lightly while watching the picture on the screen. If it jumps when any one tube is tapped, this is the likely trouble-maker.

Vertical Overlap

Causes—Defective vertical-deflection yoke, defective vertical-oscillator, vertical-amplifier or output tubes. Misadjusted height or vertical linearity.

Cures—Substitute—one by one—for the tubes mentioned above.

Check the adjustment of the vertical-linearity and height controls. In many cases, trouble of this sort is caused by an attempt on the part of juvenile members of the family to "fix the television set."

Deflection yokes have several small components—resistors and condensers—mounted inside the cardboard casing. If the foregoing cures are ineffective, it is advisable to remove the yoke and check these components with an ohmmeter. It may not be possible for the amateur to identify which is the horizontal and which the vertical section by tracing the leads. To find out quickly, disconnect the yoke and measure the coil resistances, which are given in the service bulletin. If the resistance measurements of the wire that compose the coils match those given in the bulletin, the coil itself is all right. To check the small components themselves, one end of each should be disconnected, otherwise the readings may be inexact.

Picture is Split
Or Two Complete Pictures
Appear Vertically

Causes—Improperly set vertical-hold control, or a defective component in circuit.

Cures — Readjust the vertical-hold control.

Look for a defective tube in the vertical-sweep and sync circuits by substitution. It is unlikely that any of these will cause the difficulty, but it is possible and should be attempted as it's one of the easier things to do. Possible defective components are: vertical-oscillator transformer, resistors and condensers in the oscillator and amplifier circuits.

No Picture, No Sound
Picture Tube Not Lighted

Causes—Receiver not plugged into electrical outlet, power cord defective, safety-interlock switch not properly connected, fuse in receiver blown, power-transformer primary open, defective on-off switch, defective low-voltage-rectifier tube, open tube filament in a.c.-d.c. sets, short in set, etc. There are other causes possible for this trouble. Some can be very obscure.

Cures—Remove the receiver plug from the electrical outlet and test the outlet by plugging in a lamp to make sure none of the house fuses has gone bad.

Check the power cord for an obvious break. If an ohmmeter is available, check continuity by connecting it to the prongs on the power-cord plug. The line should read open—infinite resistance—with the power switch in the "off" position. In the "on" position, there should be a reading of some sort. Lack of a reading with the power switch turned to the "on" position indicates an open power cord, poor contacts or a defective safety-interlock switch, a defective "on-off" switch, an open primary in the power transformer or, possibly, some other open circuit among the most common of which would be the fuse. All possible troubles which can be checked without completely removing the chassis from the cabinet should be investigated. The interlock, the power cord and usually the fuse can be checked merely by removing the back of the set. Replace defective wire or switches.

CAUTION should be exercised if the fuse is found to be defective. Often a fuse will open because of age, a small surge in the power supply or for some other very temporary reason. However, it must be borne in mind that a fuse is a protective device and that the usual reason for its failure is that some circuit in the receiver has developed a short, thus drawing excessive current. If the fuse does not open but permits this condition to go on, it is quite possible that the continued operation of the receiver will cause one or more components to burn out, wires to burn and a great deal of damage to follow. Therefore, whenever a fuse has gone bad, do *not* short it out by wrapping tinfoil around it or jumping the contacts with a piece of wire. Replace it with a fuse of the same value. This is a simple matter. Fuses are most commonly of the "pigtail" type, that is, a small glass tube, metal-capped at each end and with a wire lead soldered to the metal cap. Small "snap-on" devices are available on the market which can be snapped on the fuse in the circuit and another good fuse snapped on the back of the device. The photos on page 11 show how this is done. Whenever a new fuse is needed, it is a simple matter to snap it into the snap-on fuse holder. Further replacements can be made without effort.

A less commonly used method of connecting a fuse into a circuit is by use of the "fuse-extractor post." This is more expensive for the manufacturer, entailing an additional component besides the labor of installing it. However, some receivers do have such posts, generally at the rear of a chassis. Replacement of a fuse in this case is done by simply unscrewing the cap, removing the fuse and inserting a new one. As always, care should be exercised to replace with the proper-sized fuse.

"Slo-Blow" fuses are often found. A "Slo-Blow" fuse is one which will not open immediately with a slight current surge or build-up such as occurs in filter condensers, but opens only after the rating has been exceeded for a short period of time. Thus the nuisance of changing fuses constantly because of small surges is alleviated and the temptation to insert fuses of higher value to reduce the number of blowouts is removed.

The procedure to follow in replacement of a defective fuse is simple but should be adhered to rigidly. Insert the fuse of the proper value. Turn on the receiver and watch very closely for any sign of arcing, smoke, smell of burning, odd streaks on the screen of the tube or other indications of trouble. If these do occur, turn the power off immediately. The indications given show that the fuse went out in its capacity as a safety device and not because of some trouble within itself.

Perhaps the most common cause of a dead receiver is failure of the low-voltage rectifier tube. If inspection shows the filaments of the tubes to be lighted but there is no sound, picture or raster, the first culprit to suspect is the low-voltage rectifier. This supplies B-plus voltage in almost all receivers except a very few with a special power supply. Check this tube then by inserting a known good one. Rectifiers are 5U4G, 5V4G, 6X5, 5Y3, 7X6, 25Z5, etc. Note that the letter following the first digit in rectifier tubes is usually one from the last part of the alphabet. Remember that some receivers use more than one low-voltage rectifier tube, in particular those with 5Y3 tubes.

In some types of a.c.-d.c. television receivers, where the tube filaments are in series, failure of the filament of one tube will cause the whole receiver to become inoperative just as failure of one light in the old-fashioned Christmas-tree series circuits would cause a whole string to go out. If the pins on the tube base to which the filament leads are connected are known, each tube can be tested for this defect with an ohmmeter. Otherwise, find the difficulty by substitution or by removing the tubes from the receiver and having them tested.

Replacement of a defective on-off switch, a defective power transformer, an open circuit in the receiver or similar troubles is too difficult for the average person to undertake unless he is positive where the trouble is. Open transformers and defective switches are best found by checking continuity. They should be replaced with a manufacturer's replacement or by a standard type. In some cases, a transformer which is proper for the job cannot be mounted without drilling new mounting holes in the chassis. If tools are available, this is not difficult to do and often quite feasible in that it enables a "stronger" unit to be used in replacement than was originally installed. Generally speaking, work of this type should be left to the serviceman.

No Picture, No Sound Picture Tube Lighted

Causes—Reasoning will show that in this case the high voltage is operating, the receiver is getting power and the trouble must lie in some section which carries or in some way controls both the audio and picture signals. The fault could be in the antenna or its lead-in, the tuner, or, in receivers using the intercarrier system, the intermediate-frequency amplifier circuits.

Cures—Check the antenna system for a break in any of the connections either at the antenna itself or along the lead-in or at the point at which it is connected to the receiver. If a folded-dipole antenna is used, the lead-in and antenna can be checked by connecting an ohmmeter across the conductors at the receiver end without going on the roof. If continuity shows, the trouble lies elsewhere. Indoor antennas are highly suspect as they are handled so much that leads are more often broken.

Check the tubes in the tuner by substitution. The most likely offender is the oscillator tube. Tubes used in tuners are 6J6, 6AG5, 6AK5, 6BC5 and 6BC6. It is possible in some types of tuners that the switch mechanism has become defective and no contact is being made when the knob is turned. This is rare, however. Repairs on tuners are quite critical, particularly if they involve realignment and circuit-component replacement, so that most servicemen prefer not to tackle the job but will usually recommend a new replacement.

Check the tubes in the intermediate-frequency amplifiers. This applies to the intercarrier-type receivers where the sound and picture signals follow along the same path to the detector tube. Common tubes are 6AU6, 6BA6, 6AC7 and 6CB6.

Open resistors, open coils, open or shorted condensers and the like can cause this trouble. Simple tube failure or a break in the antenna lead is the cause in almost all cases, however.

Sound But No Picture (Tube Does Not Light)

Causes—The failure must lie in a circuit which lights the picture tubes or controls the electron beam or video output. Therefore, the possibilities are the picture tube itself, the high-voltage power supply, the horizontal-sweep circuits and the vertical-sweep circuits or the video-output circuits.

Cures—Check the picture tube and make sure the filament is lighted. This is seen by looking inside the neck of the tube after removing the back cover. If the filaments are not lighted, either the transformer which supplies the voltage has become defective, a socket or connector between that source of power and the picture tube has lost contact or the tube itself is bad. If a voltmeter is available, the output of the kinescope filament transformer can be checked. If the transformer is defective, replacement should be made in the usual manner. Sockets and connectors are easily checked to make sure they are not loose or that a lead is not broken. In some picture tubes, it has been found that the filament wires are not properly connected to the pins on the tube base. If this is the case, the tube is defective and should be repaired or replaced by the dealer, distributor or manufacturer under the terms of the warranty. If the sockets, connectors, transformers, etc., are good, and the filaments do not light, the inference to be made is that the picture tube is defective and should be replaced.

If the high-voltage power supply is defective, there will be no light on the picture tube. Perhaps this is the most common failure in television receivers and in the majority of cases it is due to a simple tube failure. The presence of sound indicates that the low-voltage power supply is functioning properly. Therefore, only those tubes directly affecting the high voltage need be test-

ed. As most receivers use the flyback or kickback high-voltage system, the failure of the horizontal-oscillator tube which provides the triggering impulses will cause the high voltage to go out. Check by substitution. The common tubes are 6SN7, 6SL7, 6AL5, 12SN7, 12BH7, 12AU7. Next, substitute the horizontal output or amplifier tubes—6BG6, 6BQ6, 6CD6—and the high-voltage rectifier tubes—1X2, 1B3, 2X2, 2V3. Occasionally, high-voltage power supplies are independent of the other portions of the receiver in which case all tubes in the supply are potential offenders.

CAUTION! In making substitutions in the high-voltage supply, be sure the power cord is disconnected and all discharge precautions are carefully observed. Replacement of other components in the high-voltage power supply are made in the usual manner.

Check the tubes in the video-output circuit.

Check the ion trap. There are times when a receiver is jarred so badly that the ion trap becomes misadjusted. This is a rather complicated adjustment which most people will find best performed by a serviceman.

Adjust the brightness and contrast controls. If these are defective they can cause the trouble cited. However, such a cause is most uncommon. More common, oddly enough, is the fact that some people fail to turn up their brightness controls and call a serviceman to repair a nonexistent defect. Defective small components, controls and the like cannot be found with certainty without test instruments. If instruments are available, the standard continuity and voltage checks will isolate the trouble so that repairs can be made.

Sound But No Picture, Tube Lights

Causes—The trouble must lie in a circuit which affects only the video signal. This could be the video i.f. circuits, the video detector or the video output. One further cause is possible. Occasionally, a "screwdriver" mechanic will attempt to better his picture by adjusting i.f. transformers or some tuner components. If the picture is lost because of this there is no recourse but to call the serviceman and let him take the receiver to his shop for a complete realignment.

Cures — Replace the tubes in the video i.f. circuits. These are 6AU6, 6CB6, 6BA6, 6AQ5, 6AC7, 6AL5, 6AG5.

Replace the video-detector tube—6AL5, 12AU7.

Replace video-output tubes — 12-AU7, 12SN7, 25L6, 6AC7, 6AL6, 6V6.

Open coils, resistors, etc., are found by using test instruments.

Picture But No Sound

Causes—Defect must lie in those circuits which carry only the audio signal. These are the audio i.f., audio detector or discriminator, audio amplifiers and speaker.

Cures—Check the speaker cable and plug to make sure that contact has not become broken. This sometimes happens during a housecleaning period when a mop or broom is pushed under a console television receiver.

Check the audio-output tubes first—6V6, 6K6, 6F6, 6L6, 25L6, 7C5—then the audio-amplifier tubes, which can be the same types plus 6SQ7, 6SJ7, 12-SQ7, 12AT6, and then the detector or discriminator tube. Audio-detector tubes are many and varied, but the

6AL5 is the most popular in the TV sound system.

If the defect is not uncovered at this point, the next step is to try the audio i.f. tubes. Receivers using the intercarrier method of sound detection and amplification will as a rule have only one i.f. tube in the audio system —a 6AU6, 6BA6, 6SK7, 6SJ7, etc. Those in which the sound and video signals follow separate paths have more.

If the replacement of tubes has no curative effect, the speaker can be checked. This is a most unusual difficulty and shows up generally in a gradual manner. Because of the necessity of matching impedances and the fact that some receivers use permanent magnets whereas others are the dynamic type, it is not too practical to check by substituting the speaker from another receiver—radio or TV. The simplest check is to apply an ohmmeter to the voice-coil leads of the speaker. If there is continuity or the speaker diaphragm or cone moves with a slight click as the leads are applied, then the speaker itself is not the cause of the trouble. If an ohmmeter is not available, applying an ordinary 1½-volt flashlight battery to the leads also will cause it to click and move. The leads can be identified easily in most cases. Many sets have only the two leads going directly to the voice coil from the chassis. Others may have several, some of which go to a transformer or a choke mounted on the speaker casing. The voice-coil leads can be identified by observing which are attached to the cone of the speaker itself.

The sound section of a TV receiver is very much like a regular radio receiver. The major difference lies in the fact that certain circuits of a television receiver—notably the tuner—carry both sound and picture signals. Besides the possible causes listed as trouble sources, defective transformers, coils, condensers, resistors and controls also can result in loss of sound. Trouble shooting in the audio is, therefore, to be carried on as it would be in a radio, always bearing in mind that when the set is turned on there is high voltage in the video circuits which should be avoided with care. Anyone with a knowledge of radio repair should have no difficulty servicing the sound section of a TV receiver. Without that knowledge, the services of a repairman should be used.

Distorted Sound

Causes — Defective tubes, defective components, improper alignment, rubbing voice coil in speaker, torn speaker cone, misaligned detector transformer.

Cures—The same cures as those tried for lack of sound should be tried in this case. Tube replacement is less likely to correct the trouble but should be attempted. Inspect the speaker for a torn cone. If the cone is torn, it frequently can be repaired by patching it with stiff paper similar to construction paper and cementing the patch with airplane glue. This, of course, is possible only if the tear is relatively small. A rubbing voice coil indicates complete replacement or having a professional put in a new cone. Rubbing can be checked by removing the speaker and gently pushing the cone in and out with the finger tips, taking care not to tear or punch the cone. The cone should move freely with no apparent friction.

Alignment of any sort should not be attempted without proper test equip-

ment such as a signal generator, output meter, oscilloscope, etc., as well as a knowledge of just what one is doing.

Shorted or leaky condensers, defective resistors and the like are found with test instruments.

Weak Sound

Causes — Same as in "Distorted Sound." Open condensers, changed value resistors and weak tubes are the most common causes of weak sound.

Cures—Same as for distorted sound. It is also possible that the low voltage being supplied to the audio circuits is deficient. If the picture is excellent but sound is weak and the cause is poor voltage, the circuit must be traced out to locate the seat of the trouble.

Poor alignment can be determined by adjusting the position of the fine-tuning control. If good clear sound can be obtained at any point regardless of the picture quality, then misalignment is indicated. The indicated procedure is to call a serviceman, but in some receivers an adjustment of the oscillator "slug" in the tuner will rectify the trouble. Such cases are rare and are most often found when the oscillator tube has been replaced. To adjust, gain access to the oscillator adjustments on the tuner either through the front panel as provided for in some receivers or by removing the receiver from the chassis. Make all adjustments with an insulated alignment tool, since the metal in an ordinary screwdriver affects the circuit.

Hum. Picture and Sound Good

Causes—Noisy tube, misalignment, sound traps misadjusted.

Cures — Except for checking the tubes, there is little the layman may do in this case. Misalignment is only to be corrected with proper equipment. Faulty settings of sound traps are, generally speaking, jobs for the serviceman. And, as is usual, the trouble can be caused by a faulty by-pass or filter condenser which will require test instruments to find.

Picture Smeared

Causes—Fault lies generally in the video-i.f. or video-amplifier circuits. It is necessary to amplify all portions of a video signal equally and, in order to do so, circuits composed of certain small components are designed. Any defective part in these integrating and compensating networks can cause smearing. Occasionally, one of the video tubes will become slightly defective and give the same results.

Cures — Check by substitution the video tubes.

Further attempts to correct this trouble should be made only by qualified service people.

Picture Not Centered Horizontally or Vertically

Causes — Centering controls misadjusted, deflection yoke misadjusted, centering controls shorted, ion trap misadjusted.

Cures—Adjust centering controls. If they fail to bring the position to center, but do have an effect on the positioning of the picture, the control itself is not defective but a misadjustment of the deflection yoke is indicated. To adjust the deflection yoke, loosen the holding screws that hold it in the bracket and move it slightly until the picture is centered. Be careful to keep the yoke well forward and pushed against the bell of the picture tube.

If adjustments made with the centering controls fail to move the picture at all, the control itself quite probably is shorted or the associated components in the centering circuit are defective—generally a shorted condenser will be to blame.

Misadjustment of the ion trap occasionally results in improper centering.

Picture Tilted

Cause—Misadjusted deflection yoke.

Cure—Adjust deflection yoke as described under "Picture Not Centered." Be careful to tighten the holding screws after the adjustments are made to prevent the yoke from slipping again should the receiver be jarred.

Picture Out of Focus

Causes—Focus control misadjusted, focus coil misadjusted, focus control or focus coil completely or partially shorted, ion trap misadjusted.

Cures—Readjust focus control. Occasionally, it will seem that the focus control adjustment will almost—but not quite—focus the picture. If that is the case, the focus control should be set at the center point of its rotation. Then, readjust the focus coil, which is located around the neck of the picture tube. To adjust the focus coil, it will generally be necessary to loosen the set screws which hold it in position. Carefully move it back and forth or tilt it as seems necessary to (1) focus the picture all across the screen and, (2) make sure there are no dark shadows on the screen. Some receivers have no variable focus control at the rear of the chassis or on the front panel. This type requires that all focusing be done by the focus coil, either by manipulating it manually with the back off or by means of a shaft which protrudes through the back cover.

If adjustment of the focus control has no effect, the implication is that the control itself is shorted and should be replaced. Also, resistors shunted across the control may be shorted. A shorted—either partially or complete—focus coil is best determined by using an ohmmeter. In testing the resistance of the coil, disconnect one of the leads so that the resistance of the coil only is being read.

A slight misadjustment of the ion trap will often defocus a picture. Move it in the prescribed manner to determine if this is the cause.

Occasionally, a defective picture tube is indicated by the inability to focus the picture. This is decidedly the exception rather than the rule.

Portion of Picture in Shadow or Cut Off

Cause—Misadjustment of the focus coil or the ion trap.

Cure—Readjust the focus coil and ion trap. Remember that the focus coil is an electronic lens. If it is not focused properly the electron beam will not be swept across the face of the screen in the proper manner but will be emphasized on some spots and not on others. Thus, a shadow or shadows will result. It may be necessary not only to move the focus coil back and forth but also to tilt it up and down or sideways. The ion trap is a likely offender.

Insufficient Brightness

Causes—Ion trap not set properly, picture tube defective, defective brightness control, wrong voltages supplied from power supplies.

Cures—First rotate the brightness control with the contrast turned down

low. If there is no apparent change in brightness the indication is that the brightness control is defective and should be replaced.

Readjust the ion trap. This may be necessary particularly after a set has been jarred or moved.

Replace the high-voltage rectifier tube—1X2, 2X2, 1B3 or 2V2. Replace the horizontal-amplifier or output tube – 6BG6, 6BQ6, 6CD6. Replace the horizontal-oscillator tube – 6SN7, 6SL7, 6AL5, 12AU7, 12SN7, etc. These tubes are all part of the high-voltage supply. Obviously, a picture not bright enough can mean that insufficient high voltage is being provided, and a weak tube in the high-voltage power supply can bring about that result. Replacement of the horizontal-oscillator tube often means a readjustment of the horizontal-oscillator transformer will be necessary.

If the rectifier tube—5U4, 5V4, 5Y3, 25Z6, etc.—is weak, it is possible to have good sound and still not have a bright picture as this tube supplies voltage to the horizontal oscillator. It likewise should be checked.

Replacement of the high-voltage, or flyback, transformer is sometimes necessary. Because this transformer is generally in a shielded compartment and space is at a premium, it is wise to make sure the replacement used is a direct one.

Because of the expense involved, the picture tube is usually the last item to be checked. Unless the picture has been growing dimmer gradually, there is not too much reason to suspect the picture tube itself as being the seat of trouble. The only satisfactory check to be made for a defective picture tube is direct substitution, and a picture tube is a rather expensive item to keep on hand or to purchase should the kinescope be suspected. Having picture tubes on hand for substitution checks is an advantage the professional serviceman has over the amateur.

Weak Picture, Poor Contrast

Causes – Antenna system partially shorted or connections broken, weak r.f. tube, defective video i.f. or video-amplifier tubes, defective video-detector tube, misalignment of the i.f. or video-amplifier circuits, poor signal from station.

Cures—Make certain the trouble applies to all stations by tuning each one in. If all but one are good, the inference is that the poor station has had its signal affected temporarily.

Replace the r.f. tube—6J6, 6AK5, 6AG5, 6BC5, 6BC6.

Replace video i.f. tubes – 6AU6, 6BA6, 6CB6.

Replace video-amplifier tubes—6SJ7, 12AU7, 6AG5, 6V6, 6SN7.

Replace video-detector tube—6AL5, 12AU7, 6SN7, 12SN7.

Check the antenna system from the antenna down to the connections at the receiver. Often, antennas which are mounted on chimneys gather a tremendous amount of soot and oil waste which is very detrimental to efficiency. This should be cleaned off.

If none of the above cures is effective, the most likely reason for a weak signal or picture is a misalignment of the circuits carrying the picture signal. Realignment of these circuits is a job to be performed only by a qualified technician. Also, the weak picture may be brought about by changed values of components whose locations are best determined by the technician with testing equipment that will enable him to find the weak spot.

Uneven Shading

Causes—Most common one is man-made, that is, a misadjustment of the contrast control. A d.c. restorer tube or circuit may be defective.

Cures—Adjust the contrast control when a test pattern is available to make sure the shading of the concentric rings is even and regularly graduated.

If contrast-control adjustments are ineffective, replace the d.c. restorer tube—6AL5, 12AU7—or check the last video-amplifier tube.

Picture Appears Snowy

Causes — Receiver location in a fringe area where signal is weak, antenna system not sensitive enough or not properly connected, weak amplifier tubes, particularly r.f. amplifier tube in tuner, poor alignment.

Cures—Check the antenna system. First make sure that all the leads are properly connected and that the lead-in is held in position away from gutters, etc., by stand-off insulators. Check the orientation of the antenna to make sure it is aimed at the point from which the greatest signal strength comes. Also, if the receiver is in the fringe area, be sure that the antenna used is the one which has the maximum pickup for the frequencies on which the desired stations are operating. An efficient antenna is a must in the fringe area, but even one coupled with a booster will not entirely rid the picture of snow.

Check the amplifying tubes. Just as there are various degrees of strength among healthy people, so will tubes of the same types vary in amplifying ability although all check good. When purchasing a supply of tubes to keep on hand, it is worth while asking the dealer to test several and choose those which have the highest amplification factor for the video i.f. amplifier circuits. You will probably have to pay for this service—and rightly so—but it is worth it to fringe-area dwellers.

If stronger tubes, good antennas and proper orientation do not correct a snowy picture and receivers of the same make and model in the same locality do have good pictures, take the receiver to a serviceman and have him completely realign it and check it thoroughly for good solid connections.

Poor Detail, Picture Not Clear and Sharp

Causes—Poor alignment, misadjusted fine-tuning control, occasionally, but seldom, defective components.

Cures — First make sure that the cause is not misadjustment of the fine-tuning control by tuning in a station with the test pattern on. If unable to adjust the fine-tuning control so that the lines in the vertical wedges are sharp, clear and not merged until they reach the center of the pattern, then the assumption is poor alignment. This is a job for the serviceman.

Picture "Blooms" and Appears Too Large

Causes—Defective high-voltage power supply, defective picture tube.

Cures—Check the tubes in the high-voltage power supply, particularly the rectifier—1B3, 1X2, 2V3.

Defective small components in the high-voltage power supply. To be checked with instruments.

Defective picture tube. Check by substitution.

Picture Very Dark and Dull Brightness Control Operates O.K.

Causes—Defective high-voltage power supply, misadjustment of the ion trap, defect in the d.c. restorer circuit, defective picture tube.

Cures—Adjust the ion trap for best position.

Check the tubes in the high-voltage power supply.

Check the d.c. restorer tube, if any.

Check the picture tube by substitution.

The most common causes of this trouble are a maladjusted ion trap and/or a defective picture tube. As it is unlikely that the ion trap will become misadjusted unless the receiver is jarred, the picture tube itself must be held up as the probable cause.

White Lines Through Picture

Causes — Brightness control turned too high, d.c. restorer circuit defective, low-voltage-to-picture-tube components improper, defective condenser in video-amplifier section, defective video-amplifier tube, vertical deflection critically set.

Cures—This is a difficulty that can be brought about by a multitude of causes and is most annoying. It can be present with a poor picture or a good one. Sound is seldom affected. Unless the simple cures correct the trouble, it is unwise to delve too deeply into the receiver as the offending component may be obscure and difficult to find.

Readjust the brightness control. Too much brightness will make the retrace lines visible. Back it off till the lines are blanked out.

Check the d.c. restorer tube by substitution. If no tube is used in this circuit, then the various components must be checked with test instruments.

Check the setting of the vertical-hold control. Occasionally, if these controls are set just at the point where the "rolling action" stops, the retrace lines will appear. Rotate the control until the picture is firmly locked in position.

Check the video-amplifier tubes by substitution. There is a possibility that a defective tube in these circuits may be causing the trouble. A leaky condenser in these circuits can also be the cause.

Check the components in the video-amplifier section.

If the picture is weak and the sound not too good, replace the low-voltage rectifier tube — 5U4, 5V4, etc. This should bring up both the sound and picture and erase the lines. If it does not, suspect some other component in the low-voltage power supply.

A defective picture tube can cause this trouble, but it is most unlikely. If the foregoing remedies have failed to correct the trouble, the services of a professional repairman are called for.

Negative Picture

Causes—Defective picture tube, defective video circuits, overloaded power circuit.

Cures — Check the picture tube. This is often an indication of a defective picture tube.

Check the video amplifier and video i.f. tubes—6AU6, 6BA6, 6AG5, 6CB6, 6SJ7, 6SN7.

Check the video-detector tube — 6AL5, 12AU7, 6H6, 6SN7.

Components in any of the video circuits can be suspected in this trouble. Usually, however, the difficulty may lie in a phase-shifting network, crystal diode or some hard-to-find component.

Ghosts on Picture

Causes – Reflections from external surfaces to antenna or mismatched impedances in the transmission-line.

Cures—Check antenna for direction and line interferences.

Top or Bottom of Picture Blacked Out

Causes—Defective low-voltage power supply, horizontal-sync circuits defective, clipper circuits defective. (Usually accompanied by a wavy action of the picture.) Defective vertical-sync circuits.

Cures—Replace tubes in horizontal-sync circuits—6SN7, 6AL5, 12AU7, 12SN7.

Replace tubes in vertical-sync circuits—same as above.

Check sync-separator tubes—12AU7, 12SN7, 6SN7, 6AL5.

Check tubes in vertical-sync circuits, particularly if the picture is blanked out in the top half and the flyback-retrace lines are visible. In almost all cases when part of the picture is blacked out the fault lies in either the sync or clipper circuits and is specifically a defective tube.

Occasionally a defective filter condenser which will allow an alternating current ripple to pass will have the same effect. Therefore, if tubes are not to blame, filter condensers that apply particularly to the sync and video circuits should be suspected.

Picture Fades In and Out

Causes—Virtually all receivers have an automatic gain-control circuit, called AGC, whose purpose is to compensate for slight variations in signal strength and thus maintain an even picture. If the picture fades in and out, therefore, either this circuit is defective or the variations in signal strength are too great for the AGC to compensate. Causes, therefore, could be a defective AGC tube, a defective component in the AGC circuit, a loose antenna which sways in the wind, airplanes that interfere with or reflect the signal, or a defective video-detector tube, which often provides the AGC voltage.

Cures—Check the antenna system. Make sure that the mast is firm and steady. See that guy wires are taut. Inspect the lead-in to make certain that it is not loose and flapping. Check the lead-in for frayed spots and good connections at the antenna.

Substitute the AGC tube, if any—6AU6, 6AG5.

Check the video-detector tube—6H6, 6AL5, 12AU7.

Check for loose connections in the video circuits, particularly at the antenna input, the r.f. amplifiers and the tuner.

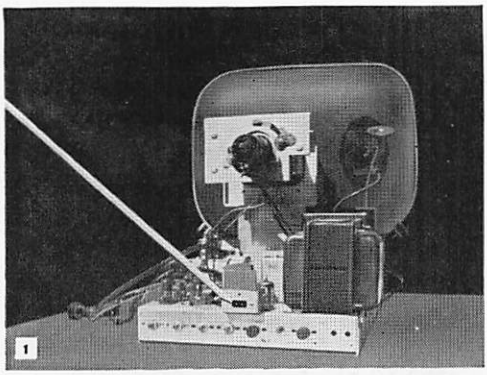
A defective filter condenser in the AGC circuit will cause this trouble also.

Black Bar of Varying Width Across Center of Picture

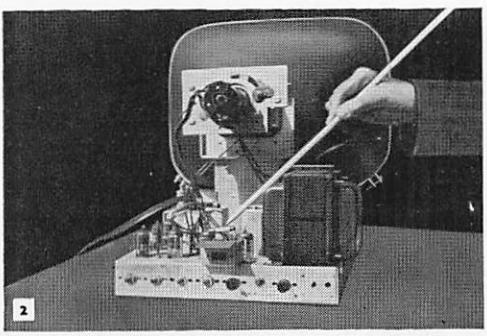
Cause—This indicates the "60-cycle hum" is present in the video circuits. The usual 60-cycle alternating current which supplies power to the receiver is rectified and filtered. This keeps a varying voltage from being applied to the wrong places. Therefore, if it appears on the picture, some filtering component is defective.

Cures—Check the filter condensers in the high and low-voltage power supplies. If the sound is free from hum at the same time that the bar appears on the screen, the indication is that

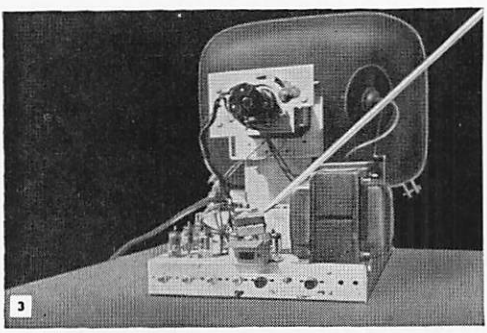
Danger points because of high-voltage buildups in your television set are illustrated on this page. There will be no hazard, however, if you carefully "bleed" the current off these points by shorting them to the metal chassis of the receiver. This picture series also is excellent for familiarizing yourself with your TV set.



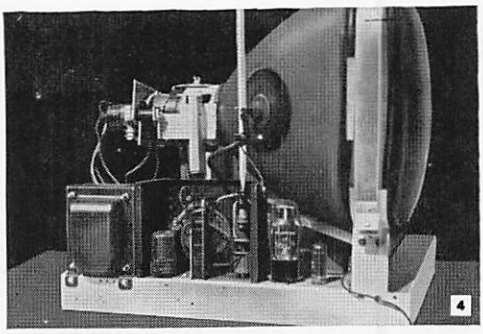
Power-input safety lock



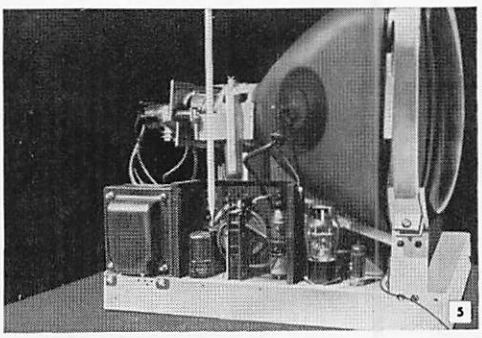
Exposed power fuse



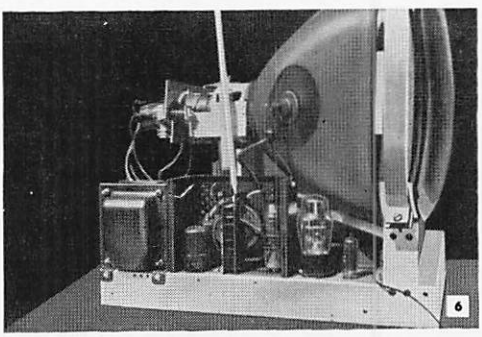
Snap-on fuse holder



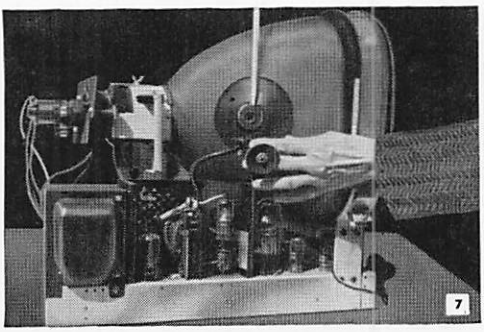
High-voltage rectifier tube



High-voltage amplifier tube



Flyback transformer unit



Second anode of picture tube

the low-voltage power supply is functioning properly and the trouble is most likely in the high-voltage power supply.

Check the filter condensers and the high-voltage condensers in the sweep circuits.

Check the filter condensers in the video amplifiers.

Purple or Brown Spots on Screen

Cause—Defective picture tube.

Cure—A new picture tube is the only remedy for this trouble.

Intermittent Performance Of Either Sound or Picture

Causes—An "intermittent," in the professional repairman's vocabulary, is a defect which occurs only occasionally—sometimes lasting for a few seconds—and is caused by loose elements in a tube, loose wires, defects in condensers, resistors or coils and the like. This trouble is often very difficult to find.

Cures—To locate a suspected intermittent tube, tap each one lightly with the finger or a rubber mallet. The finger tap, of course, must not be given to any of the high-voltage tubes. Nor is it necessary to hit a tube with a rubber mallet—a pencil end will do just as well.

Tap other suspected components with the end of an insulated screwdriver or some similar light object. Be careful not to use conducting metal when the set is turned on, as it must be when trying to locate an intermittent. Also, be careful not to place a screwdriver shaft or any conducting material across leads in such a manner that they are shorted together. Do not ground any lead to the chassis unless you know what you are doing.

Carefully inspect solder connections. Occasionally a joint is not soldered at all in the manufacturing process. "Rosin" joints are suspect. These are connections where the soldering job has been done improperly so that only a coating of rosin is present instead of a firm joint of solder. These can be determined by turning off the receiver, grasping leads firmly with a pair of long-nosed pliers and gently wiggling them. Care must be exercised so as not to break the lead or the lug to which it is connected.

Another cause of intermittent operation—the defective condenser, resistor, etc.—is more difficult to cure. To find a component that acts properly some of the time and improperly the rest of the time is extremely difficult. Trouble of this sort is the type that makes it necessary for your serviceman to keep your receiver for a long period of time. He cannot cure a trouble that doesn't show up long enough for him to find it any more than you can. It should be realized that the intermittent trouble is one which may be extremely simple to find or extremely difficult. If vibrations of any sort, such as those brought about by walking across a room, will cause the receiver to act intermittently, it is likely that something in the receiver is loose or a tube has a defect. This type of trouble can usually be located readily. If, however, the trouble is one which comes and goes as the set is or isn't warmed up, or appears and disappears for no reason at all, the trouble is more obscure and may require treatment in a service shop.

Receiver Noisy When Jarred Or Subjected to Vibration

Causes—Microphonic or noisy tube

in the sound system. Loose connection in cable from chassis and sound output to speaker. Defective tube socket in sound circuits. Worn volume-control contacts.

Cures — Tap tubes to determine which is the offender. It will almost always be one of the sound amplifier tubes.

If tapping the tubes definitely locates the trouble in one spot but replacement of the tube by a known good one does not cure the difficulty, the socket or the connections of the leads to it should be suspected. To check this it will be necessary to remove the receiver from the cabinet and inspect the socket at the underside. Using an ohmmeter to check from the lugs at the bottom of the socket to the points at the top through which the tube pins are inserted will show up a broken socket lug.

Check the cable connecting the speaker to the receiver. The connectors may have worked loose. Occasionally leads are stripped too far or are frayed in such a manner that they rub against the chassis or another lead. Tape the frayed spot or move it away from the point of contact. Rotate and tap the volume control to locate noise at that point.

Noisy Volume Control

Causes—Dirt or worn spots.

Cures—Wash the control by pouring carbon tetrachloride on it from an oil can or with a medicine dropper as it is being rotated. This will wash most of the dirt out.

If washing the control still does not correct the trouble, and particularly if the sound is distorted or dead at one setting of the control, it should be replaced. This is done in the usual manner by ordering the direct replacement part. In making the replacement, the receiver must be removed from the cabinet. Unscrew the nut which holds the control in place, label the wires or draw a picture showing which color lead goes to the various solder points, disconnect the old volume control and install the new one. This is a simple job, easily performed. The control will cost from $1.25 to $1.75, approximately, whereas paying a serviceman to do the work will cost from $5.00 to $10.00.

Interference

Causes—Diathermy, automobile ignitions, electrical equipment, other television receivers, amateur radio operators, internal — such as misaligned sound traps.

Cures—Interference cures can best be discussed generally. Interference shows up in various forms—noise in the sound system, horizontal bars from FM interference, loss of vertical synchronization, a curlycued band across the screen caused by diathermy, flashes of light from ignition, flutter by airplanes, moving black dots across the screen, herringbone lines from other television receivers and the like. Internally, if the sound traps are not properly aligned within the receiver, the energy of the sound signal will "leak" through to the picture circuits. This trouble is easily identified, since the interference form will appear in synchronization with the sound as it is spoken or played. The cure for this is a realignment by a serviceman.

If FM interference is suspected, try to tune in the FM station by adjusting the fine tuning control. If the FM station is heard when the volume control is turned up, the simplest cure is to

call a serviceman to adjust the FM trap on the tuner. This trap is usually a combination of condensers and coils at the antenna input to the receiver and can be located by following the antenna lead to the point where it connects with the receiver. Some service bulletins definitely locate the trap and make it easy to find. The interference is eliminated by adjusting the screw shaft on the coil until the FM sound and interference disappear. This is an adjustment that must be carefully made while watching the picture to make sure that its tuning is not disturbed. It will not be possible to locate an FM trap on many tuners; in that case call the serviceman.

Interference from other television receivers is best cured by relocating and reorienting the antenna. It is caused by radiated signals from the oscillator of a nearby receiver, by reradiated signals from a neighboring antenna, radiation from nearby objects and the like. The best cure is to make sure the antenna installed is equipped with a reflector and director to sharpen the directivity of its "aim" and to locate it as high as possible.

Interference from ignitions is best cured by locating the antenna as far away from the street as possible and not running the lead-in in such a way that it will pick up the noise. Should this not be sufficient to cure the trouble, use a shielded lead-in for the antenna. Shielded lead-in consists of the conventional two conductors enclosed in a metal shield. The shield is connected to the chassis of the receiver while the two conductors are connected in the usual way to the antenna terminals. The shield is best connected to the chassis through a .01-mfd. condenser and can also be connected to a good ground. The final effort to be made in reducing ignition interference is to install a filter specifically made for the purpose. If the interference is caused by electrical equipment, the first step is to clean the unit to minimize arcing. If there is no condenser connected across the brushes on a motor, one should be installed. This again is a .01-mfd. condenser. Installing a filter in the power-line input to the television receiver will often cure the trouble. These are obtained at radio-supply houses, where they are known as "power-line filters."

Filtering of the power line and reorienting or relocating the antenna are the only possible cures for correcting diathermy interference. If neither remedy does the job, the only hope is to be patient and await the day when the offending physician finds it necessary to discard his old diathermy machine and purchase a new one which is properly isolated and shielded to prevent radiation and power noise.

Interference from a radio-amateur's station may be very hard to cure and at the same time can be one of the easiest. It may entail shielding part of the television receiver and it may entail shielding the whole cabinet. The easy part of the cure lies in the fact that radio amateurs as a group are well-informed on the subject of radio and interference and are generally more concerned by the fact that they may be interfering with your TV picture than you are. These amateurs do fine work, perform national services and are to be encouraged rather than castigated. If amateur interference is noticed, therefore, locate an amateur in your neighborhood, call him up and tell him your troubles. In practically all cases he will help you locate the of-

fending transmitter and see that steps are taken to correct the trouble. If the offender is not a radio amateur but one of the many government and commercial transmitters, the "ham" will help identify the frequency of the signal and advise you on the type of filter to install. Treat him well; he can be a good friend to you in your TV problems.

Offending electrical devices in the home can be easily located by noting whether the refrigerator, sewing machine, furnace, or the like causes interference when it goes on. Correct it by making sure each motor has been properly cleaned and that the contacts at the brushes are not arcing. Any motor-repair shop will do the job quickly and cheaply. This has a double advantage as the majority of home electric motors receive too little attention as it is, therefore are dirty and inefficient.

Arcing in the Receiver (Identified By an Audible Cracking or Buzz)

Causes—Short in a high-voltage lead, loose connection, improper shielding of high-voltage points.

Cures—Watch the high-voltage section of the receiver while it is in operation. If the room is dark, careful inspection—without touching the receiver—should reveal a visible spot which will locate the source of arcing. Turn off the receiver and discharge the condensers in the usual way by shorting out the danger points to the chassis. If the arcing has been caused by a high-voltage lead running too close to the metal chassis or shield cage of the high-voltage supply, move it far enough away to prevent the arcing. If the spark seems to be jumping from the cap of one of the tubes to another lead or surface, or if it is located at any solder point or contact point, two courses are indicated. The first step is to brush off all dust on the offending source. Then purchase a jar of anticorona fluid at a radio-supply house and coat the surfaces of the joints or tube caps thoroughly and completely with it.

If the high-voltage lead to the picture tube seems to be the offending item, wrap it with a good polyethylene tape and coat it with anticorona fluid. Ordinary friction tape is not an insulator worth mentioning for the radio-frequency, high-voltage arcing of this sort.

Arcing occasionally will occur at the point where the high-voltage lead snaps onto the picture tube. Inspect this to make sure that it is properly seated and that no dust is present which might provide a path for the current to travel over.

Above all, in searching for high-voltage arcing, be extremely careful not to touch the receiver or push your nose in too far. The high voltage can jump a considerable distance and a nose or finger is as good a place to jump to as any.

Another important warning is necessary before you touch the controls around the neck of the picture tube—the ion trap, the focus coil and the deflection yoke. Any adjustment of these units must be done with the back cover of the receiver off and the power turned on. The chances are that your set or the instruction manual which came with it bears a warning that the back cover should never be removed except by a serviceman. It is this which frightens many people and which does present somewhat of a hazard when due caution is not exercised.

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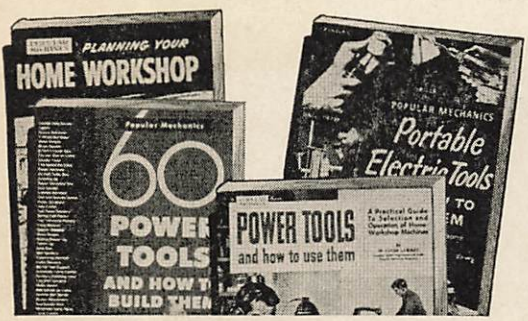

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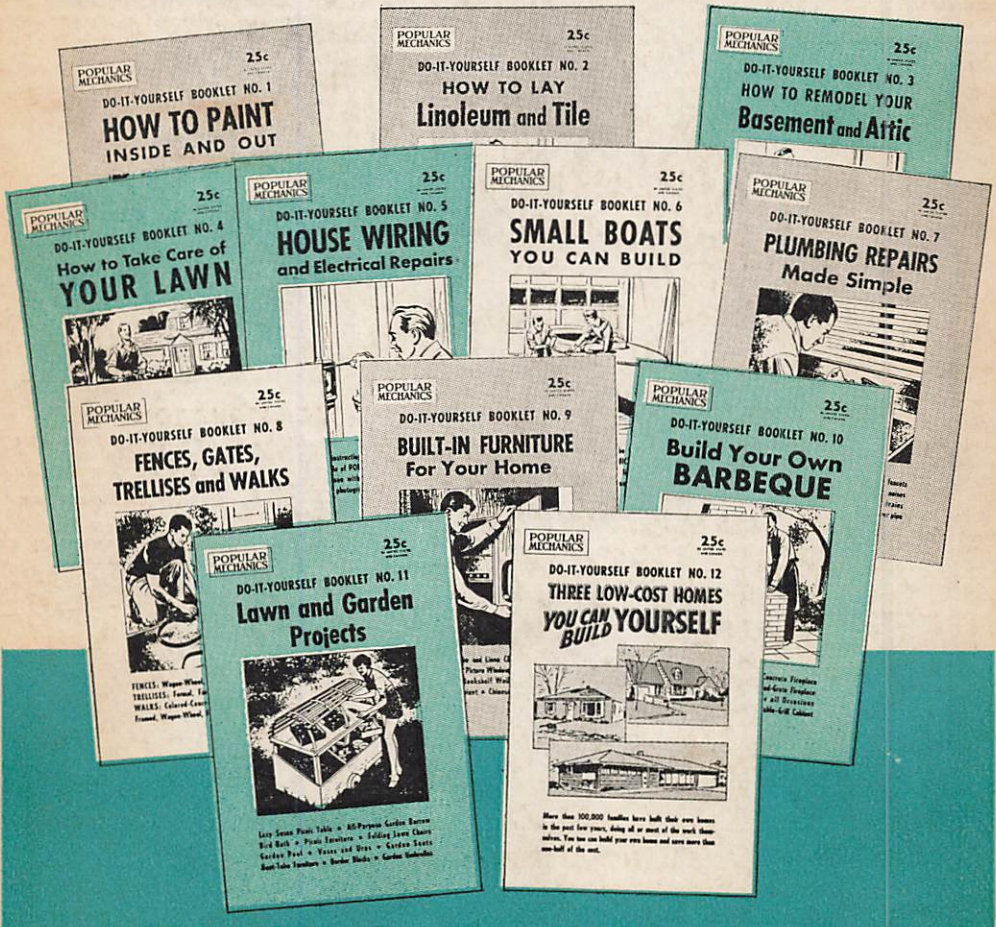

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