INSTALLATION AND ADJUSTMENT OF TV RECEIVERS

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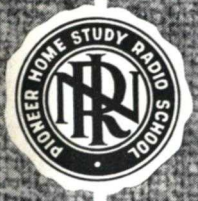

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STUDY SCHEDULE No. 61

For each study step, read the assigned pages first at your usual speed, then reread slowly one or more times. Finish with one quick reading to fix the important facts firmly in your mind. Study each other step in this same way.

☐ **1. Introduction** . . . . . **Pages 1-4**
Among the matters discussed in this section are the steps in an installation, where to work, safety precautions, and how to unpack a set.

☐ **2. Installation of Direct-View Tubes** . . . . . **Pages 4-10**
Here you learn how to install picture tubes in the most common mounts used for electromagnetic and electrostatic tubes.

☐ **3. TV Controls and Tuning** . . . . . **Pages 11-16**
In this section, you learn what the various controls on a TV set are and how to tune a set properly.

☐ **4. Adjustment of Direct-View Sets** . . . . . **Pages 16-25**
This section contains instructions for adjusting all the non-operating controls of sets using electromagnetic and electrostatic direct-view tubes.

☐ **5. Projection Sets** . . . . . **Pages 25-32**
General instructions for installing picture tubes in and adjusting the focus of projection sets are given in this section.

☐ **6. Making the Installation** . . . . . **Pages 33-36**
Here you learn how to install the set in the proper location in the customer's home.

☐ **7. Answer Lesson Questions and Mail Your Answers to NRI for Grading.**

☐ **8. Start Studying the Next Lesson.**

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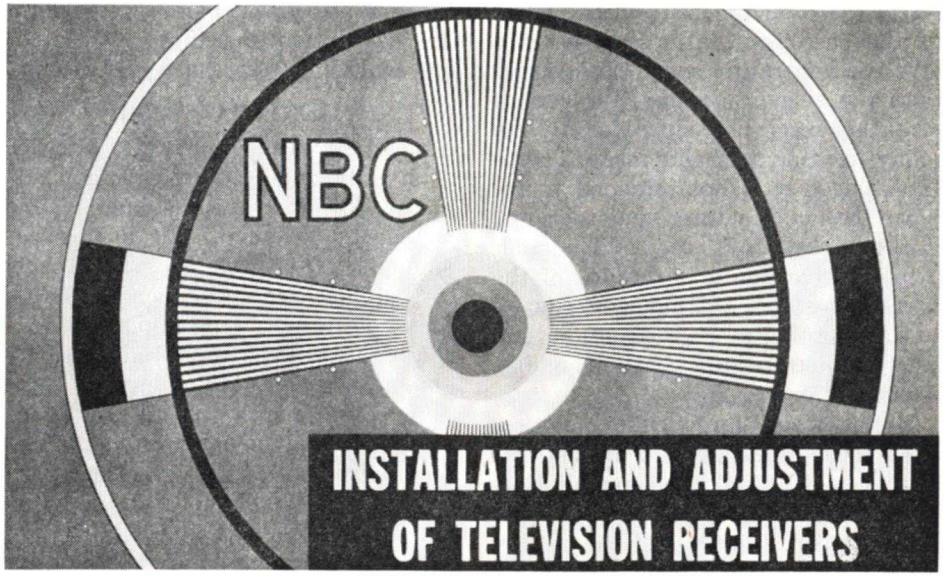


WHEN a television receiver is first put into operation, there are a number of servicing procedures that may have to be carried out, ranging from a purely mechanical procedure of installing a picture tube, through an adjustment procedure, to actual servicing for some breakdown. Then, after a period of operation, some of these steps will have to be carried out again —for example, the picture tube will eventually wear out and have to be replaced, or some adjustment or repair will have to be made.

Since certain breakdowns produce symptoms that are similar to those produced by misadjusted controls, it is necessary for the serviceman to be able to distinguish between them, and the easiest way to do this is to carry out an adjustment procedure first. If this does not correct the symptom, then a service procedure is indicated. In this Lesson, we are going to cover the adjustment procedure; actual servicing for breakdowns will be covered elsewhere.

In order to give a complete coverage of TV set adjustment, we are here assuming that we have a set to be installed and that it needs the "works." However, in actual practice, very few of the steps given in this text may be required on any one set at one time. That is, one set may need one adjustment, and another set may require an entirely different one. Hence, you need to know them all so that you can carry out those that are called for in each instance.

Even the procedure of installing a picture tube may not be required on some new sets, because it is becoming standard practice with some manufacturers to ship the sets with the tubes installed. However, many sets are shipped without picture tubes, and it is necessary to install one before the set is delivered to the customer. And, of course, you must remember that eventually this tube must be replaced, so the same installation procedure will be needed.

Although in this Lesson we are going to give the complete installation procedure from the unpacking of the

* Photo above, courtesy NBC.

set to the final touch-up in the home of the customer, naturally we must give the general or basic steps rather than the specific details. We cannot give the exact procedure for all the many sets that are being made. Therefore, this text is not intended to replace the manufacturer's instructions; it should be considered as a supplement to give you a basic idea of the necessary steps, so that you can go to the manufacturer's instructions and get the details quickly and understandably.

Before we go any further, let's see what the various steps in an installation are. To make an installation, you would usually:

1. Unpack the set and the picture tube, and install the tube if it is not already in place.
2. Check the set in the shop. Make whatever adjustments are needed to get proper reception.
3. Deliver the set to the customer's home and place it in the desired location.
4. Connect the set to the temporary or permanent antenna.
5. Re-check the set and correct any adjustments that have slipped during delivery.
6. If a temporary antenna is installed, place it where it will give the best results.
7. When the permanent antenna is up, orient it to give the best possible reception.
8. Install a wave trap, boosters, a light filter, magnifiers, or other supplementary items that are needed or desired by the customer.
9. Show the customer how to operate the set.
10. Call back a few days later to make sure the set is operating properly.

We shall describe all these steps in this Lesson, except for steps 6, 7, and 8, which are treated in other Lessons. However, before we get into the installation procedure, there are a few general matters we should discuss.

WHERE TO WORK

Some servicemen make a practice of installing the picture tube and adjusting the set in the customer's home instead of the shop. We do not recommend your doing so with a new set; in fact, we recommend strongly that you do not. One important reason is that the set may need considerable adjustment. If you have to work quite a while to adjust the set properly, the customer, who will undoubtedly be watching your every move, will probably get a poor opinion of either the set or your ability. In addition, customers almost invariably ask many questions; they may prove annoying when you are trying to devote all your attention to the problem of getting the set to work properly.

In servicing a set, however, it is best to do the work in the customer's home if possible. There are several reasons for this: the sets are usually heavy and awkward to carry; there is always a chance of damaging the picture tube if you move the set; and the customer usually dislikes to be without his set any longer than is necessary.

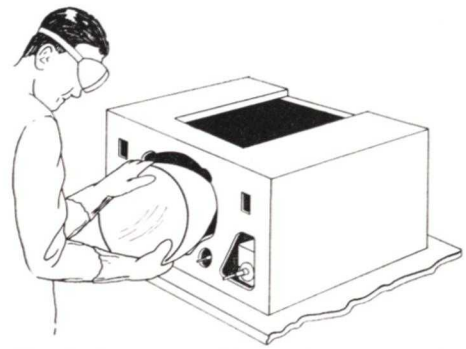
SAFETY PRECAUTIONS

When you are working with or around a picture tube, there are several important safety precautions that you should observe.

A picture tube is very highly evacuated. Consequently, there is a net air pressure of approximately 14 pounds per square inch on the outside of the tube. Because of the large surface area of the tube, the total force on it is very large, and there is danger of an "implosion" (explosion inward) if the tube is cracked or broken. It is possible to be badly cut by flying glass if this happens.

Therefore, you should always wear goggles, heavy gloves, and either a leather apron or a heavy shop coat when you handle the tube. Never hold the tube against your body unless it is absolutely necessary to do so (as it sometimes is if the tube is a very large one). Always be careful to hold it by the funnel (the wide tapering portion between the screen and the neck). Hold the slender neck only if it is necessary to do so to get the tube into position. Even then, support as much of the weight of the tube as possible with your other hand, which should be on the bottom edge of the tube face.

Be very careful at all times not to allow the tube to bump against any hard object nor permit it to be scratched, especially at the rim of the face. If the tube sticks when you attempt to slide it into a support during installation, do not force it; instead, find out what is blocking its entry.



This is the right way to hold a picture tube when you are installing it through the front of the cabinet.

You should also take precautions against electrical shock from picture tubes. The funnel of a metal tube, for example, is usually 10,000 to 15,000 volts positive with respect to the chassis when the set in which it is used is operating; therefore, you should be extremely careful not to touch it when the set is on. Metal tubes are now being enclosed in removable Vinylite boots as a safety measure, but you should not consider that this makes them harmless.

It is possible to get a shock from an electromagnetic glass tube when the set is not operating—or even when it is not in the set at all. Such tubes have conductive coatings on both the inside and the outside surface of the glass funnel; these form a condenser having a fairly high capacity. The inside coating is connected to the second anode, and the outside one is grounded. Since leakage between the two coatings is very low, there may be a considerable charge on this condenser even several days after voltage has been applied to the tube. You can get enough of a shock from a charged tube to startle you, and perhaps make you drop the tube, if you touch both the high-voltage terminal and the conductive coating at the same time. Even an apparently unused tube in its original carton may retain a charge that it received during its final test at the factory. Therefore, you should make a practice of shorting between the high-voltage terminal and the outer coating of the glass tube with a high-voltage test lead before you touch the tube with your hands. (Note: By "high-voltage test lead," we mean a lead having high-voltage insulation—NOT a high-voltage test *probe*, which has a high resistance built into it.) Short the tube this way several times to make sure the condenser is fully discharged.

Remember that insulation that is perfectly safe for ordinary voltages may break down when it is subjected to the high voltages used in television sets. Don't, therefore, assume that you cannot get a shock from a wire just because it is insulated.

UNPACKING A SET

As we said earlier, sets may be shipped with all tubes but the picture

tube in place, but very frequently the picture tube is already installed also. The control knobs are usually packed in a small bag that is secured inside the cabinet. Sometimes there is protective packing around some of the tubes, particularly the power tubes. This should be removed before you start to install the picture tube (or to adjust the set, if the picture tube is already installed).

Additional braces are often fastened to large consoles to prevent the cabinet from being broken during shipment. These braces should be left in place until the set is delivered into the customer's home, because they will protect it during delivery. Of course, you should be very careful when you remove outside wrapping and protective packing that you do not damage the set, the chassis, or the tubes in any way.

If the picture tube is shipped in a separate carton instead of being installed in the set, remove it carefully from the carton after making sure that it does not carry a charge. Remember, a glass tube may retain a charge from its final test at the factory; the shock you might get from it would not be dangerous, but it might well be enough to startle you and make you drop the tube.

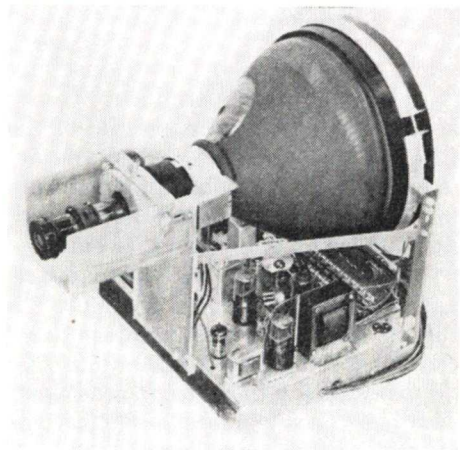
There is no possibility of getting a shock from a metal tube that is not in a set. However, it is important not to handle such tubes by the glass section of the tube funnel, because finger marks on this section of the tube may create leakage paths that will interfere with reception and may create a shock hazard. Such tubes should therefore be handled only by their metal rims. If the glass part of the funnel is accidently touched, you should wipe it clean with a soft cloth that has been moistened with carbon tetrachloride.

Installation of Direct-View Tubes

There are two types of sets in use today—one in which the image is formed on the face of the tube for direct viewing, and a second that uses a projection system. The latter will be described later in this text.

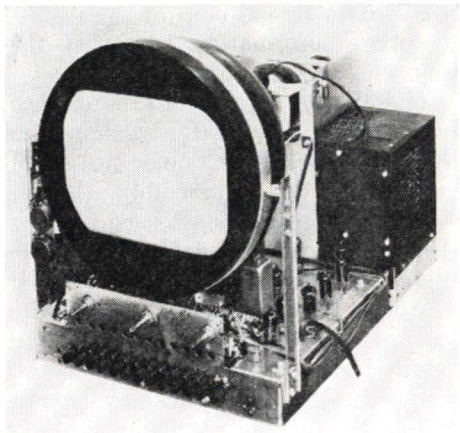
Whenever you have to install a direct-view tube, whether as a part of the initial set-up or as a service procedure, you will find that the tube has two supports: 1, at the front end of the funnel where it joins the face; and 2, either at the base of the funnel or a little farther back on the neck. Most of the weight of the tube is on the front support.

A basic difference is in whether the front support is attached to the chassis or is built into the front of the cabinet. The most common way of supporting the front end of the tube is to have it rest in a cradle secured to the chassis with a metal strap or a band of webbing running over the top of the tube to keep it from shifting.



Courtesy The Hallicrafters Co.

One common method of mounting a picture tube on a chassis.



Courtesy The Hallicrafters Co.

Notice that this mount permits the position of the front end of the tube to be adjusted.

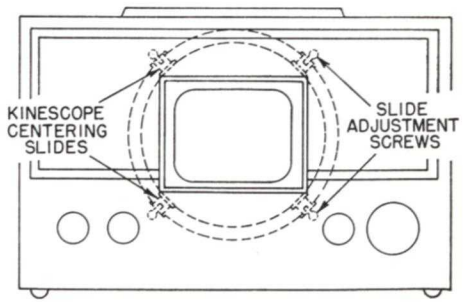
Another method of supporting the front end is to have it rest on brackets that are secured to the inside front of the cabinet. The position of these brackets is usually adjustable so that the tube can be properly oriented with respect to the mask in the front of the cabinet. This difference calls for a change in the method of installation, as we shall show.

Generally, the rear support is mounted on brackets that are supported on the chassis. On an electrostatic tube, the rear support is a strap around the neck of the tube or a mounting plate that holds the socket. However, the neck of an electromagnetic picture tube is supported by a deflection yoke and a focus coil into which the neck is slipped. The deflection yoke is usually secured inside a fiber sleeve that bears a cushion in its front end. This sleeve is usually held in a clamp that is secured by thumbscrews or nuts. If you loosen these nuts, you can move the sleeve back and forth. In addition, the deflection yoke can be moved back and forth or rotated within the sleeve by loosening a thumbscrew or nut. The mounting screws that hold the focus coil to its bracket can be loosened if it is necessary to adjust the position of the coil.

There is another variation—in some sets, both the front and rear supports of the tube are secured to the cabinet and are completely separate from the chassis. This arrangement is used in some 7-inch table-model sets and also in some large sets using a console cabinet.

In at least one set using a 20-inch tube, the tube is secured in a special cradle that permits it to be lowered within the cabinet when the set is not in use.

We shall give instructions for installing the tube in each of the first two mounts mentioned above, which are by far the most common kinds. We shall also describe the installation of



The front of the picture tube is fastened to the cabinet in this manner in some sets.

7-inch cabinet-mounted tubes. If you work on a larger set in which the tube is mounted in the cabinet, either consult the manufacturer's instructions or inspect the set carefully to learn how to install the tube.

Incidentally, if you should ever service a custom TV installation, you may find some special form of tube

mounting—in some of these, the tube is even mounted in the wall.

These differences in mounting methods call for changes in the installation procedure, and of course, there are other differences that occur because of the basic differences between electrostatic and electromagnetic tubes. For example, one of the differences is that most electromagnetic tubes use ion traps, but not all do, and no electrostatic tubes use them.

Ion traps are not used on electromagnetic tubes that have an aluminum backing behind the screen (such as the GE Daylight tubes) nor are they used on the 15 or 20-inch glass tubes. You should consult the manufacturer's information to see if the tube you are installing needs one.

There are a number of different ion traps in use; several are shown in Fig. 1. In each type, one or two small magnets are in an assembly. (Sometimes electromagnets are used.) When there are two magnets, the ion trap is supposed to go on the neck of the tube with the weaker magnet nearer the face of the tube. Fig. 1 gives the details for some types, but you should read the instructions packed with any you install. When removing an ion trap in making a replacement, be sure to notice how it was placed on the tube.

In the following, ignore instructions for installing an ion trap if none is to be used.

Now, let's discuss the installation of picture tubes in sets. We'll start with the installation of electromagnetic (EM) tubes, then take up the installation of electrostatic (ES) tubes. So that you will find everything in one place when you refer to this Lesson in the future, we shall discuss each installation separately and completely—there will, therefore, be a certain amount of repetition in the instructions. Remember — these instructions will apply both to the installation of a tube in a new set and to the installation of a replacement tube in a set that has been in use before.

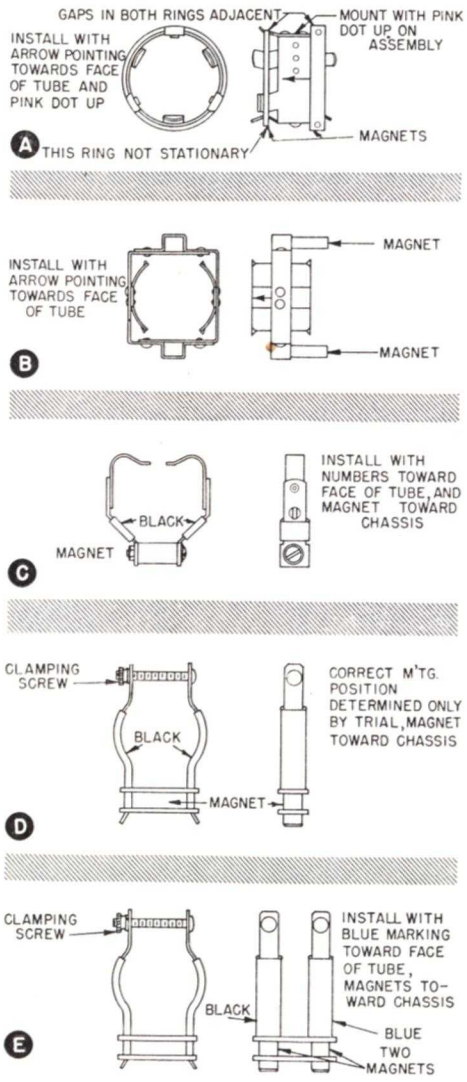


FIG. 1. Five kinds of ion traps. The one in A is the most common.

CHASSIS-MOUNTED EM TUBE

When an electromagnetic picture tube has both its front and its rear support mounted on the chassis of the TV set, the chassis must first be removed from the cabinet before a tube can be installed. Usually this is done by taking out the back of the cabinet, but at least one type of set has been made in which the whole top is hinged and is moved aside to remove the chassis. Since the usual TV set is rather heavy, be sure you have a good grip on it before you try to lift it out of the cabinet.

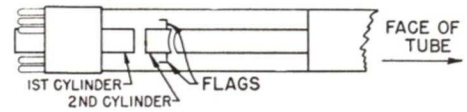


FIG. 2. These flags in the electron gun of a picture tube can be used as guides to correct initial position for the ion trap.

Before starting to install the tube, loosen the screws holding the deflection yoke sleeve to its support bracket. Remove and discard any shipping bolts. Slide the sleeve toward the rear of the chassis. Loosen the yoke in the sleeve, slide it as far back as it will go, and tighten it again.

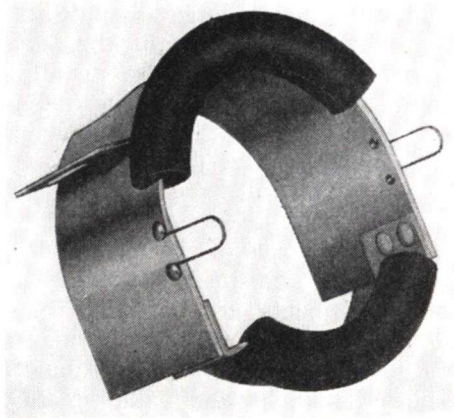
Next, align the focus coil (which is behind the deflection yoke) so that the hole in the middle of the coil is in line with the hole in the middle of the deflection yoke. Loosen the focus coil securing screws if it is necessary to shift the coil position, then tighten them after the coil is properly placed.

If a rubber mask is to fit over the face of the tube, install it. Holding the tube by the face and the funnel (NEVER by the neck), slide its neck through the yoke of the focus coil until the base of the tube is approximately two inches beyond the end of the focus coil. The high-voltage terminal of the tube is a metal well sunk in the funnel; orient the tube so that this terminal is in the upper half of the tube.

If an ion trap like the one in Fig. 1A is to be used, slip it over the neck of the tube with the smaller magnet towards the front of the chassis. The arrow on the trap should then be pointing toward the front of the chassis. (If the trap is different from that in Fig. 1A, consult the manufacturer's instructions.) Be careful not to let the tube hang by its neck at any time while you are installing the ion trap.

Most tubes have two small metal "flags" on the second cylinder from the base in the electron gun structure, as shown in Fig. 2. If the tube you are installing requires an ion trap, you can use these flags as a guide in initially positioning the trap. First, orient the tube so that the flags appear as shown in Fig. 2 when you look down on the tube. Then place the ion trap so that the rear magnet is over these flags.

After the ion trap is in place, plug the picture tube into its socket. Move the tube toward the back until its face is in the proper position with respect to the front and support.



Courtesy RCA

The front section of a deflection yoke mount.

If the strap that goes over the top of the tube face is elastic or is tightened by a spring, slip it over the tube and adjust it so that it holds the tube properly. If it is the kind that is tightened by a clamp, install the felt

or rubber cushions that are provided, then put the strap in place and tighten the clamp.

When the front end of the tube is securely mounted, slide the deflection yoke sleeve as far forward as it will go and tighten its securing clamp. When this has been done, the rubber cushion at the front of the sleeve should be in contact with the funnel of the tube. If the tube is a glass one, the two small wire loops at the front of the cushion should also be in contact with the conductive coating on the tube funnel. These loops ground the outer coating of the tube, so it is very important for them to make good contact. (These loops are NOT used with metal tubes.) When the cushion is in firm contact with the tube funnel, loosen the securing screw or nut holding the deflection yoke, slip the yoke as far forward as it will go, and fasten it again.

Plug the high-voltage lead into the high-voltage receptacle in the tube funnel. This completes the installation of the picture tube; the next step is to adjust the set. (The adjustments to be made are described later in this Lesson.) You will have to install the various control knobs on the shafts of the front controls of the receiver before making adjustments; then, when the adjustments are partially completed, you must remove the knobs and install the chassis in the cabinet, replace the knobs, and make the final adjustments.

COMBINATION MOUNTINGS FOR EM TUBES

In a set in which an electromagnetic picture tube is supported at its front end by brackets on the cabinet (but at the rear by a bracket on the chassis), the picture tube is installed from the front of the cabinet with the chassis in place. To do so, it is necessary to remove the decorative front panel to which the protective glass or plastic plate and the viewing mask for the tube are secured. Usually either the top of the cabinet or a section of the top of the cabinet must be removed also. You can expect to find some variations in the manner of securing the parts of the cabinet.

When the front panel of the cabinet has been removed, you will find a hole in the front of the cabinet that is large enough for the tube to pass through.

Before installing the picture tube, loosen the clamp holding the sleeve of the deflection yoke. Move the sleeve back toward the rear of the chassis. Loosen the deflection yoke securing screw and slide the yoke as far back in the sleeve as it will go. Tighten the yoke.

Next, see that the hole in the deflection yoke and the hole in the focus coil are in line. If they are not, adjust the position of the focus coil.

Loosen the adjustable brackets used to support the tube face. These are mounted on the inside surface of the front panel of the set. Slide the two bottom brackets to about the middle of the range over which they can be adjusted, and tighten their securing screws.

The high-voltage connection to a metal tube is made through one of these supporting brackets. Find out which bracket the high-voltage lead is connected to and make sure that the connection is secure.

If a metal tube is used, slip the Vinylite boot over the metal part of the funnel. Sometimes a clamp is provided to hold the large end of the boot to the metal rim of the tube; if one is used on the set you are working on, install it.

Holding the picture tube by its funnel, (or, if it is a metal tube, by its metal rim), slide the neck of the tube into the deflection yoke and focus coil. If it is a glass tube, orient it so that the high-voltage receptacle (a metal well sunk into the funnel) is in the upper part of the tube.

When the base of the tube is about two inches past the focus coil, install the ion trap if one is to be used. If an ion trap like the one in Fig. 1A is to be used, it should be installed so that the smaller magnet is toward the face of the tube and the red dot is uppermost. If some other kind of ion trap is to be used, follow the instructions given for its use by the manufacturer. Remember—do not permit the picture tube to hang supported only by its neck while the ion trap is being installed.

If you will look at the neck of the tube, you will see that there are two small metal flags on the second cylinder from the base of the electron gun structure (see Fig. 2). The tube should be oriented so that these flags appear as shown in Fig. 2. The ion trap should then be placed so that the rear magnet is over these flags.

Continue pushing in the picture tube until its face is slightly inside the rear surface of the front panel of the cabinet. Adjust the brackets that support the tube until the face of the tube is centered in the opening.

Wipe the surface of the picture tube and the safety glass or plastic panel that will cover it with some window-cleaning compound. The manufacturer's instructions may specify a particular kind of compound for this job. For example, RCA recommends the use of "Windex."

Put the decorative front panel back on the cabinet, being careful not to get finger marks on the surfaces that you just cleaned.

Slip the picture tube as far forward as it will go. Slide the deflection yoke forward until the cushion is firmly in contact with the tube funnel. If a glass tube is used, there will be two small loops of spring wire beside the cushion; these loops, which ground the outer coating of the tube, must make firm contact with the tube. These loops are NOT used with metal tubes.

Tighten the bracket that encloses the deflection yoke sleeve. Slide the deflection yoke as far forward within its sleeve as it can be moved and fasten it securely. Plug the high-voltage lead into the high-voltage receptacle on the funnel if a glass tube has been installed.

After installation of the control knobs on the front panel of the set, the set is ready to be adjusted, as will be described later in this Lesson.

CHASSIS-MOUNTED ES TUBE

The only basic difference between the mountings for electrostatic and electromagnetic tubes is in the neck support. The deflection yoke and focus coil are not used on electrostatic tubes; instead, there is a clamp support for the neck. However, the installation of a tube on chassis-mounted supports proceeds as follows:

First, remove the chassis from the cabinet. Install the control knobs on their shafts. If a rubber mask is to be installed on the front of the tube, install it now.

Loosen the rear support clamp on the tube (if one is used) and slip the neck of the tube through it. Slide the tube into approximately the right position, then plug it into its socket.

If a clamp is used over the face end of the tube, install it but do not tighten it. It will almost certainly be necessary for you to re-orient the tube to square it with the mask after you have found out where the picture will appear on the tube.

Next, make any adjustments on the set that are necessary. These adjust-

ments will be described later in this Lesson. When you have found the proper orientation of the picture tube with respect to the mask, tighten the clamps holding the tube.

If the mask for the tube is part of the cabinet, it will be necessary to install the chassis in the cabinet part way through the adjustment procedure. Before doing so, wipe the face of the tube and the inside surface of the protective cover glass or plastic plate on the cabinet to remove finger prints and dust. Remove the control knobs, install the chassis in its cabinet, replace the knobs, and finish the adjustment procedure.

In some of these sets, a rubber mask that is mounted on the tube face extends through the opening in the cabinet when the chassis is installed. This might be considered to be a combination of chassis and cabinet mounting. When you are working on such a set, make sure that the mask goes through the cabinet opening as it should.

CABINET-MOUNTED ES TUBE

When an electrostatic tube is supported by the cabinet, it is usual to have both the back and the front supports built in, rather than having one on the chassis and one on the cabinet. In some of the sets in which the tube is mounted in the cabinet, it is installed from the rear; in others, it is installed from the front. In the latter case, the first step is to remove the decorative panel and open the support that will hold the neck of the picture tube.

Install the picture tube in its supports, either from the front or from the rear, whichever is necessary. If the tube is mounted from the rear, wipe off its face and the inner surface of the glass or plastic shield before installing it. Tighten the tube supports enough to keep the tube from slipping but no more than that, since it will have to be moved to orient it properly when you find out where the picture appears on its face.

Connect the socket to the tube. Install the control knobs, connect the set to an antenna and to the power line, and make the necessary adjustments. These adjustments will be described later in this Lesson.

After the correct position of the tube has been found, tighten the front and rear tube supports firmly. If the front panel is removed when you install the tube, wipe the face of the tube and the inner face of the glass or plastic shield, then re-install the front panel that was removed.

These descriptions of the installation of electromagnetic and electrostatic tubes have necessarily been somewhat general. As we said earlier, you should read the instructions issued by the manufacturer of a particular set you're working on before you install a replacement picture tube. If these instructions are not available, however, the instructions we have given you will help you to install a tube properly as long as you keep an eye out for any peculiarities in mechanical arrangements that the set you're working on may have.

Now, let's learn what controls are used on TV sets and how they should be adjusted.

TV Controls and Tuning

A television set has a number of controls on the front panel and within or on back of the set itself. The adjustment of each of these controls affects the performance of the set in some respect. You must therefore know where each of these controls is and what it does before you can adjust the set properly.

Table 1 lists the various controls that may be found in a TV set and tells briefly what each does. (Notice that several names are given for many of the controls. In each case, one of these names is applied to that particular control by one manufacturer or another.) All sets do not have all these controls, but practically all sets have at least the first eleven of them. Some of these are "operating" controls, meaning that they are located on the front panel of the set and are, or can be, adjusted by the set owner to get or to improve the picture. The others are non-operating controls that are located inside the set, behind a panel in the front of the set, or in back of the chassis; these seldom require adjustment except for an occasional touch-up. Certain of the non-operating controls, notably the focus control and the ion trap, consist in some sets of a coil or other part whose position can be mechanically adjusted to produce the desired effect on the operation of the receiver. (The focus control is an operating control in a few sets; in these, of course, it is an electrical control, not a mechanical one.)

In addition, some of the controls listed consist of two or three controls in some sets. An example of this is the horizontal linearity control, of which some sets have three, each exerting varying degrees of control.

Before we describe the adjustment of sets, we shall describe the functions of the most commonly used controls.

The station selector is the main tuning device of the set. You are already familiar with this control and with the fine tuning control that is associated with it in many sets, so we shall not discuss them further. The volume control is like that used in radio sets; this, too, needs no further discussion.

The contrast control might be described as a volume control for the video signal. It can be used to vary the signal in the video amplifier or in the video i.f. amplifier, depending on the circuit arrangement of the set.

The other controls of a television set can be classified into four groups: 1, controls that affect the characteristics of the beam; 2, controls that affect the synchronization of the sweep voltages and currents; 3, controls that affect the dimensions and position of the picture; 4, controls that affect the shapes of the sweep voltages. We shall discuss each of these groups of controls in the order given.

Controls Affecting Characteristics of Beam. The ion trap, the focus control, and the brightness control affect the content, size, and energy of the electron beam. The function of the ion trap (used only with certain electromagnetic tubes) is to bend the electron beam so that the beam can pass through an aperture in the second anode of the tube. The magnetic field of an ion trap is usually supplied by permanent magnets, but some electromagnetic forms of ion traps have been used.

Table 1

	CONTROL	USE
1.	Station Selector, Channel Selector, TV Tuning	Selects desired TV station.
2.	Volume, Volume Control, Sound Volume	Adjusts sound volume.
3.	Brightness, Brilliance, Background	Adjusts average light intensity.
4.	Contrast, Picture, Picture Control	Adjusts video signal amplitude.
5.	Width, Horizontal Size, Horizontal Amplitude, Picture Width Control	Adjusts picture size in horizontal direction.
6.	Height, Vertical Size, Vertical Amplitude, Picture Height Control	Adjusts picture size in vertical direction.
7.	Horizontal Hold, Horizontal Speed, Framing	Adjusts free-running frequency of horizontal oscillator.
8.	Vertical Hold, Vertical Speed	Adjusts free-running frequency of vertical oscillator.
9.	Horizontal Centering, Horizontal Position Control	Adjusts picture position in horizontal direction.
10.	Vertical Centering, Vertical Position Control	Adjusts picture position in vertical direction.
11.	Focus, Focusing Control	Adjusts C.R. tube spot definition.
12.	Fine Tuning, Sharp Tuning, Vernier	Tunes accurately to sound channel.
13.	Vertical Linearity	Adjusts shape of vertical scanning wave.
14.	Horizontal Linearity	Adjusts shape of horizontal scanning wave.
15.	Horizontal Oscillator Frequency Adjustment, Horizontal Lock	Adjusts frequency of sine-wave oscillator (a.f.c. control).
16.	Tone, Tone Control	Varies audio frequency response.
17.	Horizontal Drive, Horizontal Peaking	Adjusts amplitude of peak portion of horizontal scanning wave.
18.	Horizontal Oscillator Phase Adjustment	Adjusts phase of horizontal oscillator to pulse rate (a.f.c. discriminator).
19.	Picture Cut-off or C.R.T. Bias Adjustment	Adjusts "black" level of picture tube (grid 2 voltage).
20.	Ion Trap Adjustment, Beam Bender	Adjusts current through the ion trap magnet coils.
21.	Service Control, Screen Voltage Horizontal Output Tube	Adjusts output of horizontal amplifier (auxiliary width control).
22.	Coarse Focus	Sets range of main focus control.
23.	Phase Detector Balance	Adjusts balance of a.f.c. discriminator.
24.	Excitation, Anode Voltage Control of Projection Tube	Adjusts operating point for projection picture tube.
25.	High-Low Bandswitch	Selects input system for high or low channel group.

The beam of an electromagnetic tube is focused by varying either the position of the focus coil or the current through it; an electrostatic tube is focused by adjusting the voltage on the first anode of the electron gun. Most commonly, the focus control is a non-operating control, but in some sets it is brought out to the front panel. Of course, the latter is possible only when an electrical control is used; when the focus coil is moved physically, the adjusting screws form a non-operating adjustment.

The brightness control affects the amount of bias applied to the first grid in the electron gun of the tube in both electromagnetic and electrostatic tubes. It therefore controls the number of electrons in the electron beam; since the over-all light level produced by a bombardment of the screen by electrons depends on the number of electrons that strike it, we can say that the setting of the brightness control determines how much light is produced at the face of the picture tube. This is frequently an operating control.

Controls Affecting Synchronization. The horizontal and vertical hold controls are examples of two of these kinds of controls. These two are used in all sets. In addition, sets that have a.f.c. horizontal oscillator control systems have controls that permit the frequency of the horizontal sweep sine-wave oscillator to be adjusted and permit the horizontal discriminator to be balanced. With other locked systems, locking range controls and sometimes oscillator frequency controls are generally provided.

The horizontal hold control affects the frequency of the horizontal sweep oscillator. It is usually an operating control.

The vertical hold control affects the frequency of the vertical sweep oscillator. It, too, is usually an operating control.

Controls that affect the locking system or the horizontal a.f.c. are invariably non-operating controls.

Controls Affecting Dimensions and Position. These controls consist of a width control that affects the horizontal width of the picture, a height control that affects its vertical height, a horizontal centering control that permits the picture to be moved horizontally, and a vertical centering control that permits the picture to be moved vertically.

The setting of the width control determines how much sweep current is allowed to flow in the horizontal deflecting coil of the picture tube (or how much voltage is applied to the horizontal deflection plates in an electrostatic tube). This is a non-operating control in all cases.

The adjustment of the vertical height control determines the amount of sweep current allowed to flow through the vertical deflecting coil of the tube (or the amount of voltage applied to the vertical deflecting plates in an electrostatic tube). This, too, is always a non-operating control.

The horizontal centering control may be either an electrical or a mechanical one. If it is mechanical, it consists of some method of adjusting the position of the focus control, usually with one or more adjusting screws. An electrical control determines the amount and direction of d.c. current flow through the horizontal deflecting coil (or the d.c. voltage applied to the horizontal deflecting plates in an electrostatic tube). This is usually a non-operating control.

The vertical centering control may also be either mechanical (the position of the focus coil) or electrical. The electrical type controls the amount of

d.c. current allowed to flow through the vertical deflecting coil (or the d.c. voltage applied to the vertical deflecting plates in an electrostatic tube). The vertical centering control is usually a non-operating control.

Controls Affecting Sweep Voltage Shapes. These controls usually consist of horizontal linearity and drive controls and a vertical linearity control. Either of the linearity controls may have one or more additional controls associated with it that provide varying degrees of control. Linearity controls are not used in sets having electrostatic tubes.

There may be as many as three horizontal linearity controls in a receiver, each of which affects the shape of part of the horizontal sweep current. These are always non-operating controls.

Adjustment of the horizontal drive control determines the point in the horizontal sweep current cycle at which the horizontal output tube conducts. Therefore, it affects the shape of the horizontal sweep signal. It, too, is always a non-operating control.

The vertical linearity control, of which there may be two in a receiver, controls the shape of the vertical sweep current. It, too, is a non-operating control.

POSITION OF CONTROLS

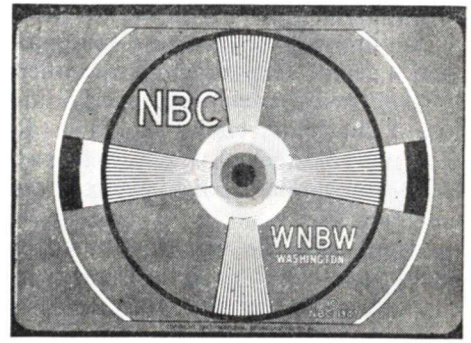
There is no general rule we can give you about where the various controls of a TV set are, except that the station selector, the volume control, and the fine tuning control (if the set has one) are invariably on the front of the set; usually the contrast and brightness controls are there also, and the horizontal and vertical hold controls are frequently there. Occasionally the focus control is also on the front panel. The other controls are usually on the back of the chassis or on top of it. In some sets, some of the non-operating controls are brought out to the front but are concealed by a panel that is secured by screws. In some sets, also, a few of the non-operating controls are on the side of the chassis. Occasionally a control is located beneath the chassis.

In almost every case, the name of the control is engraved near it on the chassis or a paper tag shows what its name is. When the tag is lost, or an unusual name is given a control, you should refer to the manufacturer's instructions, if available. If not available, you can determine its use by the process of trying it, as long as you are careful to note its original position. Do not assume that you have found all the controls on a set with which you are unfamiliar until you have checked these instructions, because there may be one or two that you do not suspect the existence of.

INDICATION OF PROPER ADJUSTMENT

It is possible to tell whether a few of the adjustments we will describe are properly made just by looking at the raster (the line pattern produced on the face of the tube when no signal is tuned in). Some others can be judged when you have a picture tuned in, but you cannot tell whether some of the controls are properly set without having a test pattern to guide you.

Test patterns are stationary pictures transmitted by a television station to assist servicemen to bring sets into proper adjustment, and they can be used to make almost all the adjustments. One of the most popular of these is shown in Fig. 3. (Some are different in appearance but the following facts apply.) If a set is perfectly adjusted, the test pattern's vertical and horizontal lines will be straight, with no moire pattern across



Courtesy NBC and WNBW

FIG. 3. The standard NBC test pattern.

them, the vertical "wedges" of lines will be equal in size to each other, the horizontal wedges will likewise be equal to each other, the circles will have no irregularities and will be perfectly circular, and the shades of gray in the center circles will range from white to black.

The test pattern also shows the width of the frequency band passed by the set (and hence indicates how well it is aligned) by the degree of separation between the lines of the vertical wedges. We shall leave alignment for a later Lesson, but we shall discuss the adjustments of controls in this one.

OPERATING A SET

Before we discuss the adjustments that may have to be made on a set to bring it into operating condition, let us take a moment to describe the process of tuning a set and producing a picture of the desired quality on its face. If you are familiar with the operation of a TV set, you need not bother with this section; it is intended for the man who has never operated one.

First, turn the set on. The on-off switch is usually on the volume (or the tone) control as on a sound receiver. Turn on this control, and adjust both the sound volume control and the contrast (or "picture") control to about their middle settings. Next, turn the station selector to the desired channel. If the set uses a push-button or step tuner, push the proper button or turn the switch to the right number; if it uses a continuous tuner, rotate the tuning knob until the indicator points to the desired channel.

If the station is on the air, you will now get an indication of a picture, at least, and you should turn up the sound volume control until sound is heard.

If the set has a fine tuning control, adjust it for maximum undistorted *sound* volume, paying no attention to the picture. If the set is receiving a strong signal, it will probably be possible to find three volume peaks at any setting of the station selector. However, two of these will be distorted; the one in the middle is the correct one.

If the set uses continuous tuning, it will probably have a double-shadow tuning eye. After adjusting the tuning mechanism to approximately the right place, make small adjustments of the tuning knob until both shadows are of the same size and are lined up with one another.

Sets that do not have fine tuning controls have a.f.c. circuits that are supposed to take care of bringing the set into exact tune when it is turned to the station. With these, selecting the desired channel is all the tuning that has to be done.

Once the station is tuned in according to the sound, adjust the contrast control to get a "normal" picture — not too black nor too white. Now, the picture must be made stationary (if it is not already so) by adjusting the vertical and horizontal hold controls. This is seldom necessary if the set was in use earlier and was

turned off without anyone's touching the hold controls.

Once a steady picture has been produced, the contrast and brightness may have to be re-adjusted to get the best picture. It is the usual practice when a set has both these controls to adjust for normal contrast with the brightness as high as it can be made without making the retrace lines visible. However, people differ in their ideas of "good" pictures just as they differ in their setting of tone controls; it is permissible to turn the brightness control higher or lower, if desired.

If the contrast control is set too high, the picture will be excessively "contrasty" — too light in places, too dark in others — and the vertical lines will usually be bent. If the control is set much too high, the picture will be severely distorted or destroyed altogether. If it is set too low, the picture will be gray, flat, and lacking in detail; if it is set much too low, no picture will be visible. A test pattern is good to experiment with; when the contrast control is properly adjusted, the center circles should shade from white to black in such a way that each circle is distinct from its neighbors.

Often, once the brightness control has been set, it is unnecessary to change the setting if the set is then tuned to another station. For this reason, some sets are made without an operating control for the brightness level. In such sets, the contrast control should be adjusted to give the best picture.

After the set has been in operation for a few minutes, it may be necessary to re-tune the fine tuning control if the set is equipped with one.

If the set is re-tuned to another station, probably the fine tuning control (if the set has one) and the contrast control will have to be re-adjusted.

Adjustment of Direct-View Sets

Now that you know how to adjust the main operating controls, let's study the adjustment of the others, particularly those considered "non-operating." We shall assume that a picture tube is installed, and that you can now connect the set to an antenna and power outlet.

To make it easier for you to see the face of the tube while you are working in back of it, place a mirror in front of the tube. Stainless steel mirrors on tripod stands are sold by parts distributors; you will find one of these very convenient for this use.

First let's run through the adjustment of sets using electromagnetic (EM) picture tubes, then study electrostatic types. In the following descriptions, the sentences in boldface type describe the adjustment step, and the succeeding paragraphs show how the adjustment is made.

EM SET ADJUSTMENT

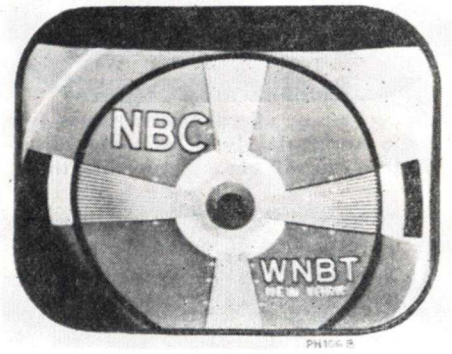
With the tube installed, connect the set to the antenna and power, and turn on the set. Turn the brightness control to its maximum setting and turn the contrast control to its minimum setting.

Position the ion trap. If the set has an ion trap, it must be adjusted *at once* to produce a visible raster on the face of the tube. If this is not done promptly after the set is turned on, the second anode of the picture tube (which is struck by the electron beam until the ion trap is properly adjusted) may be seriously damaged or ruined. To make this initial adjustment of the ion trap, rotate it or slide it back and forth a short distance until at least a fairly bright raster is produced on the face of the tube.

Remember — it is important to get the ion trap into an initial rough adjustment very quickly to prevent damage to the tube. Once a fairly bright raster has been secured, there is no longer any danger to the picture tube, so you will not have to rush the rest of the ion trap adjustment.

The position of the ion trap must be adjusted to produce the brightest raster that can be secured. If it proves difficult to locate the exact position at which the brightest raster is secured, reduce the brightness somewhat by turning down the brightness control, then re-adjust the ion trap.

Next, adjust the focus to make the visible lines in the raster as sharp as possible. Re-adjust the ion trap for maximum brightness of the raster at which the focus can be maintained.

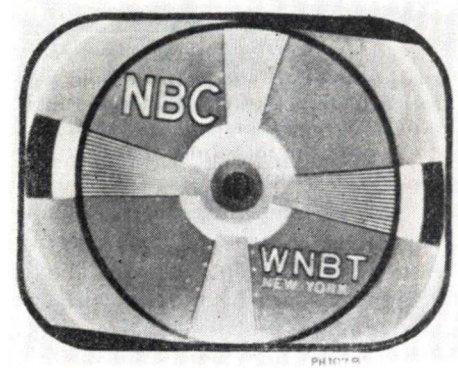


Courtesy RCA

The shadow at the bottom left of this picture is produced by an incorrect adjustment of the ion trap.

Inspect all corners of the raster carefully to make sure that none are shadowed. If shadows are present, re-adjust the ion trap to remove them. If shadows persist, the focus coil may be incorrectly positioned; hence you may have to adjust it (as described later), then return to make a final ion trap adjustment.

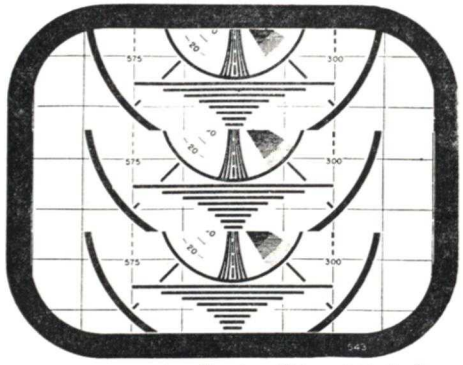
Square the raster with the mask. If the raster is not square with the picture tube mask, rotate the deflection yoke to make it so. This can be done accurately, of course, only if the mask is up against the tube. If you are making adjustments on a chassis that is not in the cabinet, and the mask is part of the cabinet, you can get the orientation of the raster at least almost perfect by making sure that the top and bottom of the raster are horizontal and the sides are vertical. However, in this latter case, remember that it may be necessary to rotate the deflection yoke slightly after the set has been put back in the cabinet.



Courtesy RCA

A tilted picture of this kind in a set using electromagnetic deflection means that the deflection yoke is rotated from its correct position.

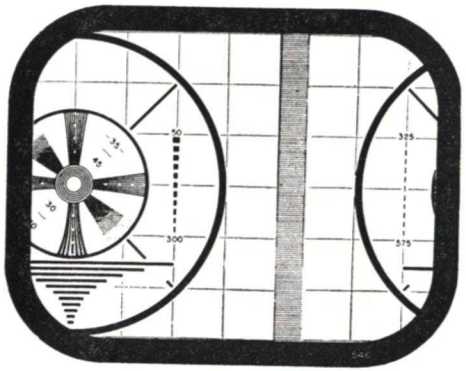
Get a steady picture. Turn the station selector to some station on the air, preferably one that is transmitting a test pattern. Tune in the station in the usual way and turn up the contrast control (which was previously turned all the way down) until the picture becomes visible, then adjust for near normal contrast. If



Courtesy Belmont Radio Corp.

Misadjustment of the vertical hold produces a picture like this that runs up or down at a rate that depends upon how severe the misadjustment is.

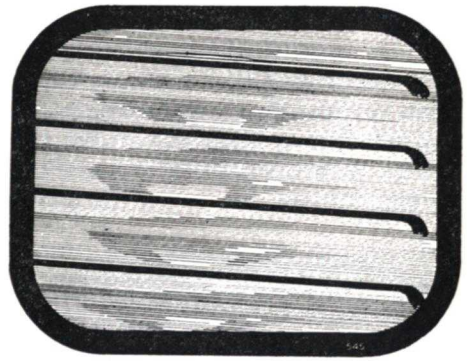
the set is operating properly, and the contrast control is not at a setting far too high or too too low, you should be able to sync the picture with the horizontal and vertical hold controls. If the picture runs vertically, turn the vertical hold control until it is stationary. Similarly, if it runs horizontally, bring it to rest with the horizontal hold control. In some sets, misadjustment of the horizontal hold control will not produce a moving picture but will instead produce one that is very highly distorted.



Courtesy Belmont Radio Corp.

If the horizontal hold is slightly out of adjustment in a set that uses the simpler kind of horizontal control, you will get a picture like this that moves slowly to the left or right.

If a steady picture cannot be produced by adjustment of the horizontal hold control, any one of several possible difficulties may exist. If the set uses one of the simple triggered systems of horizontal synchronization, the set will not lock in if the signal is too weak or if too much noise is picked up. If the set uses some locking system of synchronization, there will be an auxiliary synchronizing control that may require adjustment. This auxiliary control may be a control of the horizontal oscillator or a control in the locking circuit. Some sets have both. You will have to consult the manufacturer's instructions to see which auxiliary controls

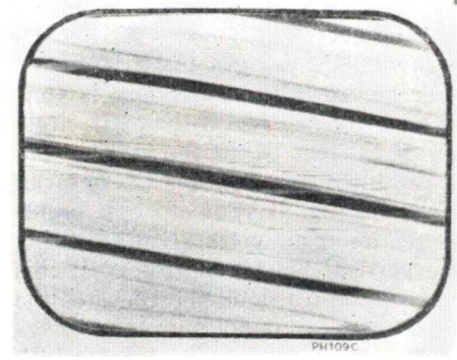


Courtesy Belmont Radio Corp.

If the horizontal hold is badly misadjusted, you will get a picture like this.

are used on the set you are working on. If you cannot get a steady picture by adjusting these controls, the set has some defect that must be found and remedied.

Check the angular range of the horizontal hold. Once you have managed to get a steady picture on the tube, check the range through which the horizontal hold control can be turned without throwing the picture out of sync. In some sets, this range is only about one half of the total possible rotation of the horizontal hold control. In other sets, the range is somewhat greater than this,

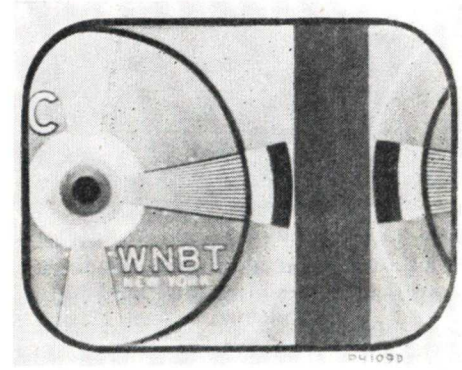


Courtesy RCA

You will get a picture like this if the frequency adjustment of the horizontal sync discriminator transformer is misadjusted.

and in still others, it is impossible to throw a properly adjusted set out of horizontal sync with the horizontal hold control. Find out from the manufacturer's instructions what the angular range is for the particular set you are working on, then check the control to see that it works as it should. If it does not, you will have to follow the instructions given by the manufacturer for adjusting the hold circuit. These instructions differ for different sets, depending upon the kind of horizontal sync system used.

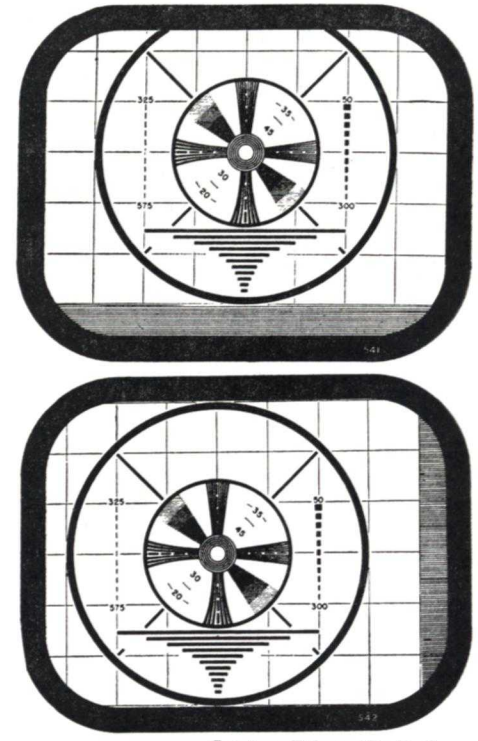
Center the picture on the tube. Some sets have electrical centering



Courtesy RCA

Misadjustment of the phase adjustment of the horizontal sync discriminator transformer produces a steady picture of this sort.

controls, others use only mechanical ones; the latter is becoming increasingly popular. Mechanical centering controls almost invariably consist of some means of tilting the focus coil on the neck of the tube, usually by adjusting two or more screws. This procedure, incidentally, is often somewhat difficult to follow if the focus coil fits tightly on the neck of the



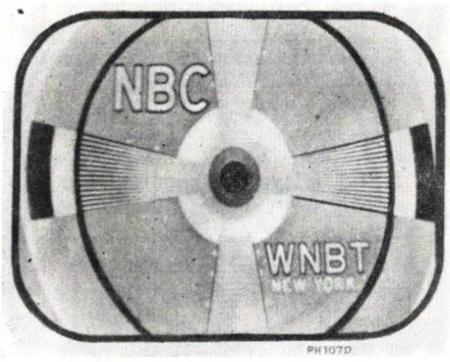
Courtesy Belmont Radio Corp.

Pictures that are off center vertically (top) or horizontally (bottom) look like this.

tube, as it does in some sets. In fact, it may sometimes prove impossible to center the picture exactly when a mechanical centering control is used. If so, it will probably be necessary to make the picture extra large so that it will fill the mask properly; we shall mention this again a little farther on.

Install the set in the cabinet. If the set had to be taken from the cab-

inet to install the picture tube, then we suggest that you put it back in the cabinet now, because the next adjustment steps are concerned with making the picture fill the mask. If a rubber mask is used over the picture tube, it will be unnecessary to install the set in the cabinet at this time. As a matter of fact, when you have had considerable experience in adjusting sets, you will probably not bother to put the set back in its cabinet just yet but will instead be able to judge the size of the picture adequately without having it in its mask. If you do install the set in the chassis at this time, first be sure to wipe off the face of the tube and the inner face of the protective glass or plastic plate on the cabinet. You must, of course, remove the knobs from the set before installing it in the cabinet and replace them afterward.



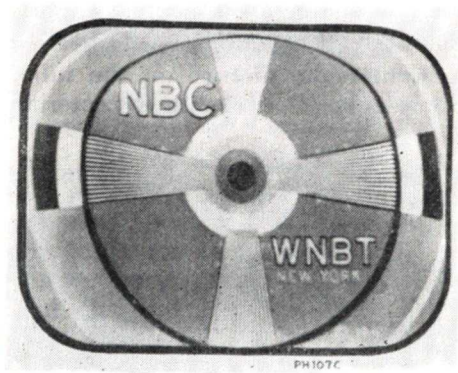
Courtesy RCA

This shows what happens when the vertical height control is misadjusted, making the picture too high for its width.

Make the picture fill the mask vertically. Adjust the vertical height control to make the picture fill the mask. If you have been unable to get the picture exactly centered because the mechanical centering system used did not permit it, you may have to drive the picture beyond the mask at the top or bottom to make it fill the mask. This is not desirable, but it may be necessary.

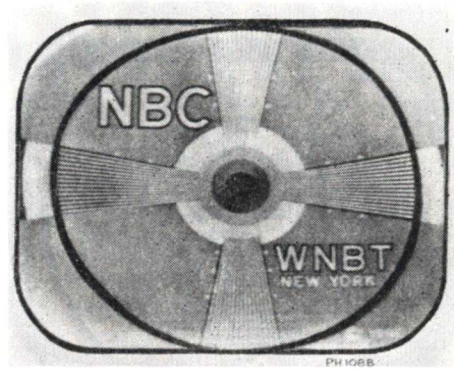
If you are using a test pattern as your picture, the picture size is considered to be correct if the main circle is just tangent to the top and bottom of the mask (see the test pattern given earlier in Fig. 3). Some people prefer to get a bigger picture by adjusting the vertical height control until this circle is well beyond the edges of the mask at the top and bottom and likewise adjusting the horizontal width of the picture to make the width greater than it should be. Doing so causes some loss of picture at the edges, but it does produce a bigger picture in the center, which is usually the part one is most interested in seeing. For shop adjustment, it is probably best to make the picture just fill the mask; you can then make the picture somewhat larger at the customer's home if he wants you to.

Adjust the vertical linearity of the picture. The vertical linearity control is used to make this adjustment. It is necessary to have a test pattern on the screen to make this adjustment well; it is difficult to make a precise adjustment of linearity on a station signature card or other stationary picture, and it is practically impossible to do so if a program is being received. The picture is linear vertically if all the lines in the two vertical wedges are straight and the vertical wedges are equal in length. (If the wedges are of equal length, but the lines are bent, and adjustment of the vertical linearity control will not straighten them, probably either the horizontal linearity is wrongly adjusted or some amplifier in the set is overloaded.) It may be necessary to make several adjustments of the vertical height and the vertical linearity control to remove the vertical distortion in the picture, since the adjustments of these controls interlock to some extent. Also, it may be desirable to repeat some of these adjustments after the horizontal linearity has been corrected.



Courtesy RCA

Misadjustment of the vertical linearity control may produce this kind of a picture.



Courtesy RCA

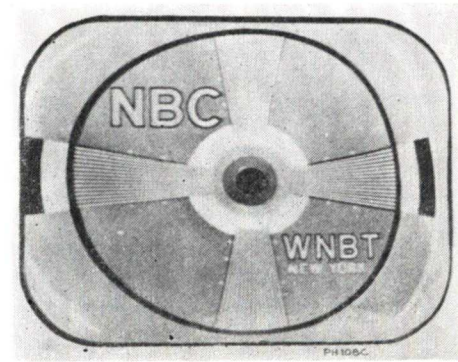
A picture distortion of this sort may be produced if the width control is misadjusted.

Adjust the width of the picture. The width control, the horizontal drive control, and the horizontal linearity control or controls must be adjusted to produce a picture that is undistorted and fills the mask horizontally. These controls interact, so you will probably have to make several adjustments of them to get the picture right. In general, you will have to adjust only the width. However, if the horizontal sweep is considerably out of adjustment, you should first adjust the horizontal drive control to get a picture of the maximum width having good linearity, that is, having the lines in the horizontal wedges straight or very nearly so and having equal wedge lengths. Next, adjust the horizontal linearity control to get the best linearity; and finally, adjust the width control to make the picture fill the mask horizontally. If the vertical size has been adjusted, the major circle in the test pattern should now be round.

If the horizontal drive control is misadjusted, the right side wedge in the picture appears to be shorter than the left one on a test pattern, and the outer circle is not round.

If the horizontal linearity control is misadjusted, the picture appears to be cramped in the middle; that is, what should be gray circles in the center of the test pattern become ovals with their long axes vertical, and the right wedge in the picture is somewhat shorter than the left one.

If the width control is misadjusted, the right wedge of the picture is somewhat longer than the left one, and the center circles of the test pattern are ovals having their long axes horizontal.



Courtesy RCA

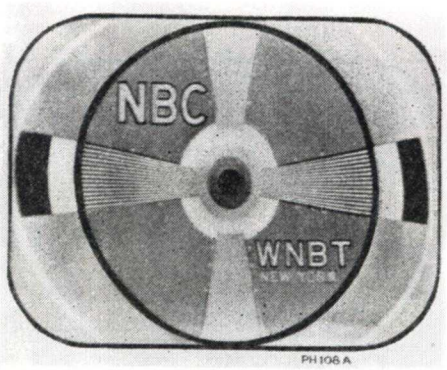
Misadjustment of the horizontal drive control may produce this effect.

If it was impossible to get the picture centered horizontally on the tube face, you may have to overdrive the picture somewhat horizontally to make it fill the mask. Again, this is undesirable but may be necessary.

If the vertical control was adjusted to give a picture larger than normal, the horizontal controls must likewise be adjusted to give a bigger picture. You can tell when the proper aspect ratio is obtained by seeing that the circles of the test pattern are truly circular even though they may go beyond the edges of the mask somewhat.

Some sets have masks having circular rather than straight sides and having horizontal top and bottom edges. The test pattern reproduction looks like that in Fig. 3, except that a slight amount of overdriving of the height may be necessary.

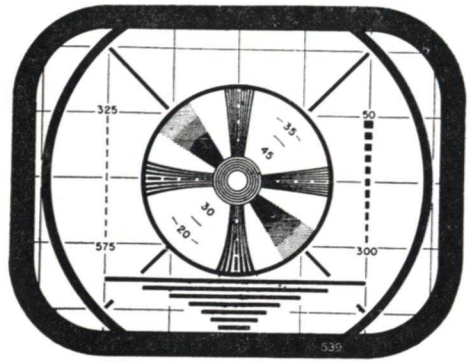
Some sets have circular masks that are approximately the same size as the full face of the picture tube. There are two possible ways of adjusting the size of the picture to make it fill



Courtesy RCA

If the horizontal linearity control is misadjusted, the effect shown here may be produced.

such a mask. One way is just to drive the picture both vertically and horizontally until it has the proper 4-to-3 aspect ratio and fills the whole mask. In this case, the tube will effectively be reproducing the center portion of a large picture, the corners and part of the sides of which will be completely lost. The other method of filling the circular mask is to distort the picture somewhat by making it just fill the mask vertically and horizontally. This will effectively make the height and width of the picture the same. The picture will therefore be distorted, because when it is transmitted it is three units high and four units wide; however, less of the picture will be wasted. When a set is adjusted in this way, the sections of the test pattern that should be circular will instead be ovals having their long axes vertical. Follow the manufacturer's instructions in adjusting the picture size in such a set.



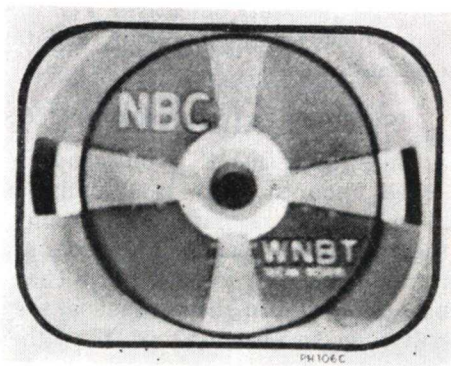
Courtesy Belmont Radio Corp.

This picture is larger than normal both vertically and horizontally. Many people prefer such a picture, particularly on small picture tubes.

Focus the picture. Adjust the focus coil control to make the picture as sharp as possible. Focusing is most easily done if the set is tuned to a station that is transmitting a test pattern, but it is possible to focus on a regular picture also if the focus control is electrical. To focus on a regular picture, find some part of the picture that is stationary and adjust the focus control rapidly back and forth through the position of best focus. This will make it fairly easy

for you to find the point at which the focus is best. If the focus control will not permit you to take the picture through the focus point, but if it instead allows you to bring the picture only into reasonably good focus before you reach the end of the control, you cannot be sure that you have the best possible focus. The focus control should permit you to bring the picture into good focus somewhere near the middle of the range of the control. If it does not, there is probably some defect in the set — perhaps some tube is losing emission. Any such defect should be found and corrected.

If the set is focused by adjusting the position of the focus coil, it is practically impossible to focus on a picture; you will have to use a test pattern or perhaps a station signature card. The reason is, of course, that adjustment of the focus coil is a fairly slow procedure, and it is very difficult to get the proper focus on a scene that changes (as it will in a regular picture if you have to take very long to make the adjustment). If it is necessary to change the position of the focus coil, it may also be necessary to readjust the ion trap to eliminate shadows in the picture. Changing the position of the coil may also affect the centering of the picture. Keep these possibilities in mind if you find it necessary to move the focus coil.



Courtesy RCA

Misadjustment of the focus coil or focus control will produce a blurred picture.

Check the set on all stations. The set should now be in adjustment for all the stations that can be received. Check this by tuning to each in turn. You may find that the best adjustment for one station's test pattern may not give as good linearity as the test pattern of another station. Usually this is caused by irregularities in the transmission from the station, so it is desirable to use the test pattern from the station considered the best operated in your locality; you can then ignore small differences found on other signals. Of course, improper alignment of the set may cause trouble this way, too, so you may have to follow the alignment procedures described in another Lesson.

SET ADJUSTMENTS — ES TUBE

Again, the sentences in bold-face type will indicate the steps in the procedure, and the succeeding paragraphs will show how the steps are carried out.

Produce a picture on the face of the tube. Connect the set to an antenna and a source of power, and turn it on. Tune in a station that is transmitting a test pattern (or a picture, if no test pattern can be found). Turn the contrast all the way down, and turn up the brightness until a raster is just visible on the face of the picture tube. Then turn up the contrast until the picture is visible.

Sync the picture. If the picture is running either vertically or horizontally, use the appropriate hold control to stop its motion. Sets using electrostatic tubes very rarely have any sync locking controls other than the hold controls. If the picture cannot

be brought into synchronization by manipulating the hold controls, usually there is some defect in the set that must be found and repaired. If a locking control is used on the horizontal sweep, however, it may have to be adjusted if the horizontal hold control doesn't lock.

Center the picture. Adjust the vertical centering and horizontal centering controls until the picture is in the center of the mask of the set. If the picture is not square with the mask of the tube, rotate the picture tube to make it so. Once the tube is properly oriented with respect to the mask, tighten the clamps that hold it in place.

Make the picture the proper height. Adjust the vertical height control until the test pattern fills the mask vertically. Since the most popular electrostatic tube is the 7-inch tube, which is a relatively small one, the customer may prefer an oversized picture; however, in shop adjustment, you should produce a picture of normal height (that is, one in which the major circle of the test pattern just touches the top and bottom edges of the mask as shown in Fig. 3). You can always increase the size of the picture in the customer's home if he wants you to.

Make the picture the proper width. Adjust the horizontal width control until the picture fills the mask horizontally as shown in Fig. 3. The circles on the test pattern should now be perfectly circular. If you have overdriven the picture vertically, you will also have to overdrive it horizontally to produce the proper aspect ratio (which you will have when the circles are true circles).

Sets using electrostatic tubes do not have horizontal or vertical linearity controls. Therefore, if the picture is not satisfactorily linear (that is, if lines in the test pattern are not straight and the wedges are unequal in size), there is no adjustment that can be made to improve this condition. The set must have some defect that must be found and corrected if the non-linearity is serious.

Focus the set. Adjust the focus until the picture is as sharp as it is possible to get it. Rotate the focus control until the picture goes through its point of best focus, then turn the control in the opposite direction until the picture goes through the point of best focus again. Repeat this process several times fairly rapidly, decreasing the amount of rotation of the control each time until you are able to stop the control at the exact point of best focus.

Check performance on other stations. The set should now be in adjustment for all stations. See that it is by tuning it to each of the other stations in your vicinity in turn. If it will not pick them all up as well as your experience in that location indicates it should, the alignment of the set is probably defective. You will learn how to align sets in a later Lesson.

SPECIAL ADJUSTMENTS

One "adjustment" you may be called upon to make is actually an alignment or replacement problem that comes up because some sets are capable of tuning in only 7 or 8 channels on a "choice" basis; that is, they will tune to either 12 or 13, either 10 or 11, etc. Manufacturers customarily adjust their sets to receive the stations that are available in the locations in which the set will be shipped. However, it is always possible that someone will move into your territory who has a set that is adjusted for different stations.

How to adjust such sets depends upon the type of set. In some, it is necessary only to change the setting of the r.f. oscillator. You will receive instructions for doing so in a later book on set alignment. Other sets use turret tuners into which new coils must be plugged if a different station is to be picked up. To adjust a set of this sort, you must secure new coils for the desired channel and install them in place of the coils used in the undesired channel. If you find it necessary to do this, follow the instructions given by the manufacturer.

How to adjust a.g.c. controls. In sets using a.g.c., the contrast control is frequently used in that circuit and acts as the only control. In others, however, the contrast control may be in the video section, and a separate "a.g.c." control may be used to set this circuit below the point of overloading. Generally, the adjustment consists of tuning in a strong signal, adjusting the contrast control to maximum, and then adjusting the a.g.c. control to where overloading in the form of a severely distorted picture just begins to appear. Now, turning down the contrast control should give normal contrast, and if the a.g.c. system is operating properly, there should be no overloading on any signal.

Projection Sets

It may take longer to adjust projection television sets completely than it does to adjust direct-view sets, chiefly because not only must the adjustments of the sort described earlier be made, but also the optical system must be properly lined up. For this reason, careful and detailed explanations of how to adjust a projection set are always given by the manufacturer in his manual. To give you some idea of what such adjustments are like, we shall describe the procedures used in the more common sets.

Projection television sets, as you have learned, use either a Schmidt lens system or an ordinary projection lens to produce a large picture from a small picture tube. In a set in which a projection lens is used, the tube is simply mounted behind the lens, and the image on the face of the tube is projected through the lens onto a wall or screen. So far, sets of this sort are manufactured only for custom installations, although modification kits are available that make it possible to convert ordinary receivers for such use.

Most of the projection sets that are sold for home use employ the Schmidt lens system in one form or another. There are three chief variations of this system in use at the present time. One is the RCA system

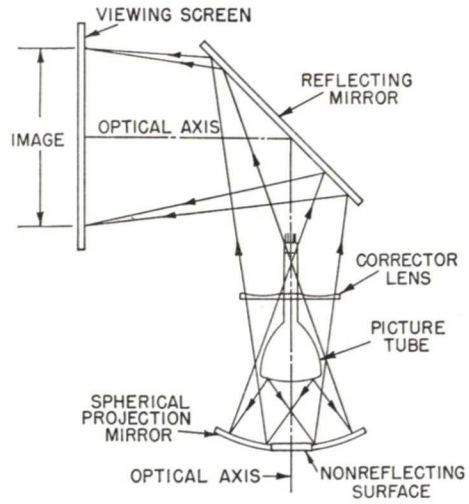


FIG. 4. The basic optical system used in RCA projection sets.

shown schematically in Fig. 4. The spherical mirror, the 5″ kinescope, and the corrector lens used in this system are all secured in a tapered mount called an optical barrel. This is mounted in the bottom of the set, which is always of the console type; the mirror and the viewing screen are mounted on the top of the set.

The system used by Philco is shown schematically in Fig. 5. A 4″ picture tube is used. One major difference between this and other systems is that the final picture is reflected from the front surface of the viewing screen. This eliminates some of the loss of light caused in other systems by projecting the picture through a screen. Another difference is the keystoning that is caused by the fact that the image is not projected onto the mirror

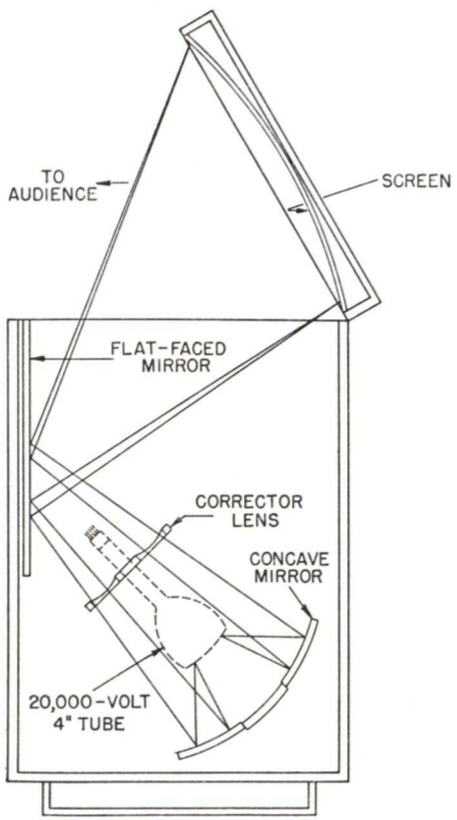
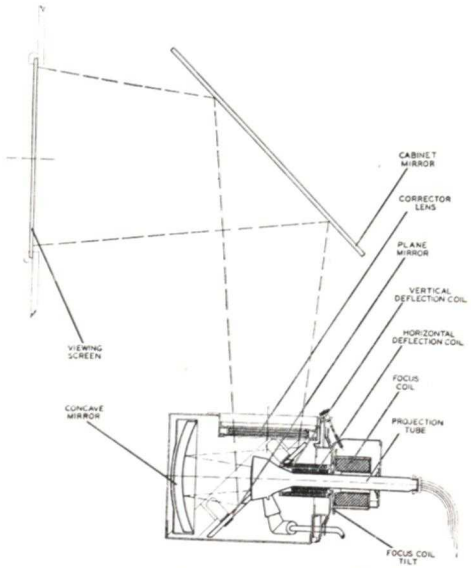


FIG. 5. The Philco projection system.



Courtesy North American Philips Co., Inc.

FIG. 6. The folded Schmidt optical system used in Protelgram projection units.

in the front of the cabinet at 45 degrees. As you learned earlier, this causes a distortion of the picture that must be corrected by distorting the original picture in the opposite manner.

The third method now in use is the Protelgram system of the North American Philips Co. (see Fig. 6). This is known as a folded Schmidt system because the optical path is bent twice between the spherical mirror and the viewing screen. This folding and the use of a very short 2½″ picture tube make the system so compact that it can be used even in table model receivers.

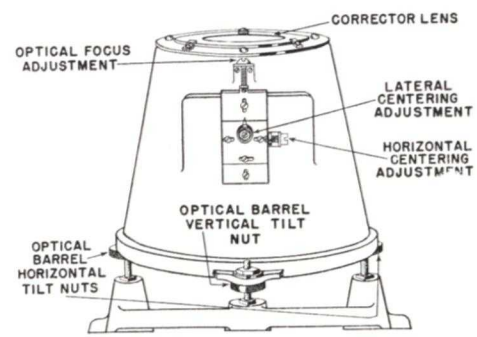
Generally speaking, the only adjustment the serviceman makes in the optical path of one of these sets is an adjustment of the position of the picture tube itself. This is done to bring the tube into the proper location with respect to the rest of the optical system so that the projected picture will be in focus. In the Philco and Protelgram systems, such adjustments must be made whenever the picture tube is replaced. In the RCA system, it may not be necessary to refocus the set after replacing the picture tube, because the tube goes in a holder that positions it, and this holder need not be disturbed when replacing the tube. In any of these systems, of course, it will be necessary to shift the position of the tube if the system becomes out of focus.

We shall now describe briefly how the picture tube is installed in each of these kinds of sets, and how its position is changed to improve the focus of the set. This information is intended to show you what is done, but not specifically how to do it. The actual installation information furnished by the set manufacturer consists of instructions to turn specific screws or other adjustments. Naturally, such information is of little value to you unless you have that exact model to service and can see exactly which adjusting device is referred to and what the effect of turning it is. Hence, we shall give only the general information that will assist you in understanding the details you will find in the set service manual.

RCA SYSTEM

The RCA system shown in Fig. 4 can be adjusted with the picture tube in place, by using a test pattern. However, RCA provides a special test lamp that makes it simpler to align the optical system before installing the picture tube. This special lamp, which works from a 110-volt power line, is placed in the picture tube holder in place of the picture tube. The lamp has a test pattern on its face that is projected through the optical system to appear on the screen, so adjustment is possible whether a signal is available or not. If the optical system is not perfectly aligned, the test pattern will be distorted. Since the test lamp is in exactly the place that the picture tube will occupy when it is installed, the system can be brought to the proper focus by making adjustments that produce an undistorted test pattern on the screen. The manufacturer's instructions show various distortions of the test pattern and tell what adjustments must be made to correct them.

To focus this set, you must first untie a canvas dust cover that encloses the space between the optical barrel and the plane mirror. Move the cover out of the way. Then, remove the corrector lens on the top of the optical barrel. Next, install the special test lamp face down in the picture-tube holder inside the barrel. Center the lamp in the holder by turning the adjusting screws in the holder. When the lamp has been installed, replace the corrector lens. It is important to put this lens back in the proper position; there is an arrow on most, and this arrow should point in the direction given by the manufacturer. Plug in the lamp cord, and rotate the lamp



Courtesy RCA

The optical barrel used in RCA projection sets.

so that the image on the screen is in the proper aspect. Next, cover the hole in the center of the lens (between the lens and the neck of the lamp) with a piece of black paper to prevent light from going through it. Replace the dust cover.

With the test lamp lit, examine carefully the pattern that is found on the screen of the set. If the pattern indicates that the lamp is not properly centered or that the system is out of focus, you can make the necessary adjustments by turning adjusting screws on the optical barrel. The picture-tube holder (and the lamp) can be raised or lowered by a "focus" screw; this changes the distance from the lamp face to the spherical mirror, and corrects the focus. When the focus is proper, good resolution should be had over the entire image. However, unless the holder has the lamp in the center of the optical path, resolution will be poor.

Other adjusting screws will move the holder from right to left, or forward and back, so it is possible to get the holder (and lamp) centered. As a check of the need for this, the focus control is moved from the proper point until a double image is seen on the screen. The lines in the two images should be parallel with each other. If the vertical lines are not parallel, the lateral (left to right) adjustment is made. If the horizontal lines are not parallel, the horizontal (front to back) adjustment is made.

If, upon refocusing, you see that the image comes into focus at some points sooner than at others, the entire optical barrel may have to be adjusted. There are "tilt" screws for this; they are adjusted until the entire picture comes into focus at the same time. The manufacturer's instructions give complete details on these adjustments.

Once the test pattern indicates the set is properly focused, remove the corrector lens and the test lamp. Install the picture tube face down in the holder in the barrel. Bring the corrector lens down over the tube with the hole in the center of the lens fitting over the neck of the tube, and secure the lens to its mounting. Install the deflection yoke, plug the socket onto the tube, and replace the dust cover.

If a picture tube must be replaced, but the optical system appears to be in good adjustment, remove the dust cover, unplug the socket from the tube, remove the deflection yoke, and remove the corrector lens. Remove the old tube and install the new one. Re-install the corrector lens, slip the deflection yoke into place, plug the socket onto the tube, and replace the dust cover. However, unless you are sure that the set was in good focus before the old tube burned out, you should check the focus with the test lamp before installing the new tube.

There are various precautions that you should observe when you are dealing with this or any other projection set. One of the most important is that you must be very careful to avoid shocks, because the tubes operate at voltages around 30,000 volts. You must also be careful not to touch the mirrors used in these systems, because they are usually silvered on their front faces and are therefore very susceptible to damage from the moisture on your fingers. If you do happen to touch one accidentally, some detergent can probably be used to clean it if you are careful. Generally, the manufacturer will specify a particular kind of detergent to be used for such cleaning. RCA, for example, recommends Dreft and water for cleaning the mirrors or the screen on their sets.

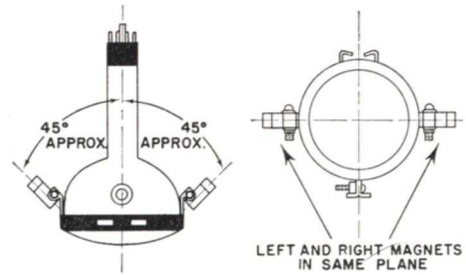
PHILCO SYSTEM

In the Philco projection television system, the picture tube is moved nearer to or farther from the spherical mirror for focusing and also can be moved from side to side to align it properly in the optical path, much as in the RCA system. However, the optical barrel is mounted at an angle, which causes the image to "keystone." This requires the use of special keystoning magnets to pre-distort the image so it will come out right, and causes the correct position of the tube to be at a slight angle with respect to the center of the spherical mirror. No test lamp is used to line up the optical system: instead, it is lined up with the set operating and with the high voltage (which in this set is about 20,000 volts) applied to the picture tube. Therefore, you should be careful about where you put your hand when you are adjusting the position of the tube.

To replace a projection tube in this system, you must first remove the spherical mirror from the bottom of the optical barrel. This is done by unlatching a strap that goes across the bottom of the mirror. Be very careful not to touch the surface of the mirror in removing it.

Next, unplug the high-voltage terminal from the tube.

There are two keystoning magnets held by a strap around the face of the tube. These magnets pick up a static charge during operation of the

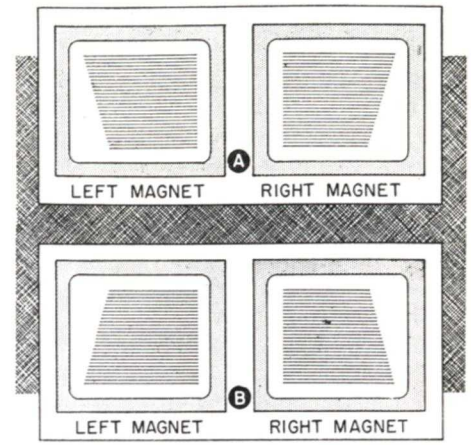


How the keystoning magnets are secured to the picture tube in a Philco projection set.

set, so you must discharge them to the chassis or the optical barrel by touching them with a grounding strap or high-voltage test lead before touching them with your hand.

The base of the tube is held by a clamp, which is at the far end of the optical barrel from the spherical mirror. Loosen this clamp and withdraw the tube.

Remove the keystoning magnets and their securing strap from the defective tube and replace them on the new tube. Orient them so that they are equally spaced with respect to the high-voltage receptacle on the tube



Part A shows the effect of under-keystoning and part B the effect of over-keystoning in a Philco projection set.

and are tilted at approximately 45° from the center line of the tube.

Slip the tube up through the deflection yoke so that its base enters the tube clamp, then tighten the clamp. Plug the high-voltage lead into the picture tube.

Focusing. Before you can adjust the optical system of a receiver using this projection system, you must produce a clear, sharp picture on the face of the picture tube, preferably with a test pattern tuned in. To do this, you must adjust the background, auxiliary background, focus, auxiliary focus, and contrast controls of the set. These are adjusted with the spherical mirror removed from the optical barrel; you must hold a small mirror under the optical barrel so that you can see the face of the tube while you are making the adjustments. The manufacturer

gives detailed and specific instructions for making them.

After the picture on the face of the picture tube has been properly focused, replace the spherical mirror on the bottom of the optical barrel. You can then observe the effect of adjustments of the optical system by watching the picture produced on the screen of the set.

First, you must get the top and bottom of the picture parallel to one another. To do this, reach in through the top of the cabinet (which permits you to reach the top of the optical barrel), slightly loosen the clamp holding the picture tube, and rotate the picture tube within the deflection yoke. This changes the position of the keystoning magnets with respect to the electron beam of the tube and thus lets you make the top and bottom of the picture parallel.

If the top and bottom of the picture are not aligned with the viewing screen of the set after you have made them parallel, you must turn the tube *and* the deflection yoke within the optical barrel to make them so. To make this adjustment, reach in through the top of the cabinet, loosen the thumb nuts that hold the deflection yoke, and rotate the yoke and the tube together until the picture and the screen are lined up properly. Tighten the thumb nuts again when the adjustment has been completed.

If the sides of the picture are not parallel to each other and to the sides of the screen, the keystoning magnets are not at the proper angle with respect to the center line of the picture tube. To remedy this condition, you must remove the spherical mirror and adjust the angle of one or both magnets. Be sure to ground each magnet to the optical barrel with a grounding strap before you touch it with your hand. You must replace the spherical mirror to observe the effect of changing the position of the magnet and then remove it again to readjust the magnet position if necessary.

When you have the picture properly lined up with the screen (that is, with the sides parallel to one another and to the sides of the screen and with the top and bottom parallel to one another and to the top and bottom of the screen), you can proceed with the focusing of the set. First, use a protractor to set the angle of the lid holding the viewing screen at exactly 67.5 degrees above the horizontal. An adjusting screw at the back of the cabinet permits you to change the angle of the screen if it is not correct.

As the first step in the focus procedure, you must move the picture tube toward or away from the spherical mirror to produce a good focus at the bottom of the picture. There is a focus lever at the top of the optical barrel that you can use to make this adjustment.

When the bottom of the picture is in good focus, tilt the viewing screen forward slowly to see if the focus at the top of the picture is improved by your doing so. If it is, turn an adjusting nut at the top of the optical barrel that tilts the picture tube so that its lower edge is brought nearer the spherical mirror. Readjust the focus control lever to bring the bottom of the picture into good focus again, and again tilt the viewing screen forward slowly to see if the focus at the top of the picture improves. Repeat the adjustment as many times as necessary until tilting the screen forward no longer improves the focus at the top of the picture.

If the top of the picture is not properly focused, but tilting the screen forward makes it worse, turn the adjusting screw in the opposite direction (moving the bottom of the picture tube away from the spherical mirror). Again, repeat the adjustment as many times as needed until tilting the screen forward does not improve the focus at the top of the picture.

When the top and bottom of the picture are brought into proper focus, check the focus of the sides of the picture by tilting the screen forward slowly again. If both sides go out of focus together, the position of the tube is properly adjusted. If one side is affected more than the other, loosen locking nuts at the top of the optical barrel and slide the assembly of the tube and the deflection yoke horizontally away from the side of the picture that improved in focus. Tilt the screen forward again to check the effect of this adjustment. Repeat this last adjustment, if necessary, until tilting the screen forward makes both sides of the picture go out of focus together.

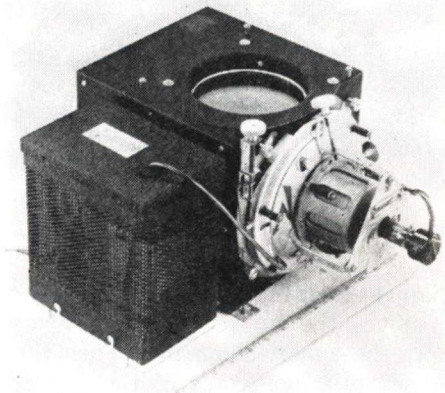
It may be necessary to go through this adjustment procedure several times to get all parts of the picture properly focused.

PROTELGRAM SYSTEM

North American Philips, the company that makes the Protelgram system, furnishes a complete optical unit and the associated high-voltage supply to various manufacturers. You can therefore expect to find this system in use in many different brands of sets.

Removal and replacement of the projection tube in this system is relatively simple, especially since it is possible to slip the whole projection unit out of the cabinet to work on it. To remove the tube, first loosen the locking nuts that secure the mounting bracket of the tube to the box in which the mirrors and the corrector lens are mounted. Next, turn the bracket counterclockwise enough to line up three slots in the bracket with these nuts. Then, withdraw the whole mounting bracket and the tube from the box, being careful not to strike the mirror through which the face of the tube projects. Unplug the high-voltage lead from the tube and loosen the clamp that holds the tube in the bracket. Slide the tube forward out of the bracket and remove the small shade that is held around the tube by a rubber band.

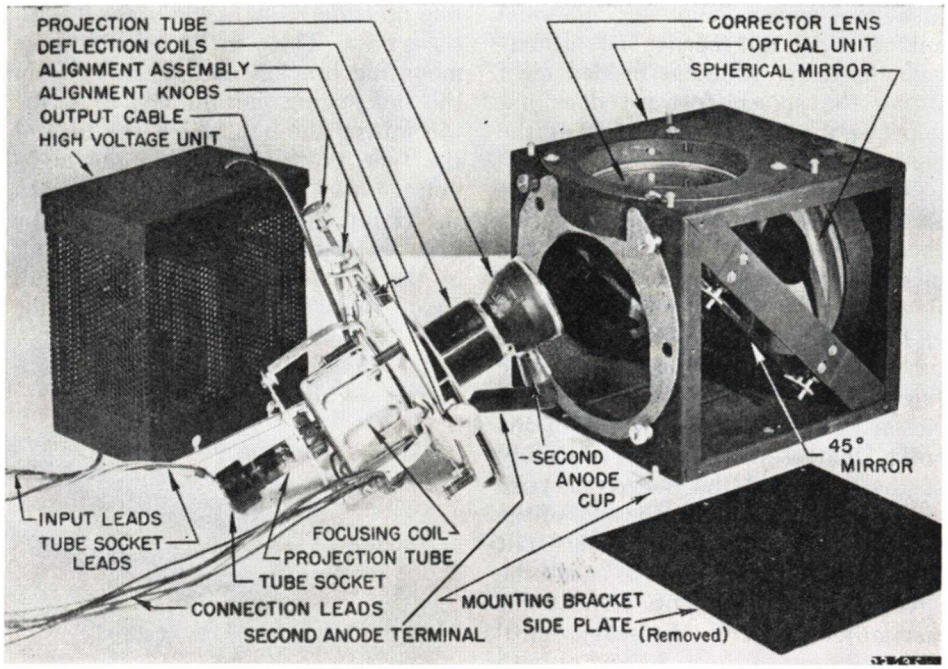
To install the new tube, reverse this procedure.



Courtesy North American Philips Co., Inc.
Outside view of the Protelgram optical and high-voltage units.

Focusing. As in the other sets we have discussed, a Protelgram optical unit is focused by moving the tube. The general procedure for focusing the unit is first to adjust electrical controls of the receiver to get the best possible focus on the face of the picture tube, preferably with the set tuned to a station that is transmitting a test pattern. Next, loosen five locking nuts on the back of the bracket that holds the picture tube.

There are three long adjusting screws on the back of the tube mounting bracket. One of these, which is at the left as you look at the tube from the base end, is the main me-



Courtesy North American Philips Co., Inc.

The components of a Protelgram optical unit.

chanical focusing adjustment; turning it moves the tube forward or away from the spherical mirror. Turn this screw until the center of the picture on the screen is focused.

If the picture is not properly aligned with the screen, align it by adjusting the Allen set screws that support the complete optical unit.

If the sides of the picture are not properly focused, turn the adjusting screw at the center of the top of the mounting bracket. Doing so moves the face of the tube up and down with respect to the spherical mirror. If this adjustment must be made, you will probably have to readjust the main mechanical focus screw.

If the top and bottom of the picture are not in equally good focus, turn the adjusting screw at the right of the tube mounting bracket. Doing so moves the face of the tube from side to side with respect to the spherical mirror. Again, an adjustment of this screw will probably make it necessary for you to adjust the main focusing screw again.

Making the Installation

Once the set has been thoroughly checked and carefully adjusted in the shop, you are ready to install it in the customer's home. This procedure includes connecting the set to its permanent antenna and orienting the antenna to produce the best possible performance. Since this subject has already been discussed in an earlier Lesson, however, we shall not repeat the discussion here.

The first step in making an installation is, of course, to take the set from the shop to the customer's home. If the shop is a moderately large one, it will usually have delivery men to do this, with the installation crew dropping around after the set has been delivered to connect it up. In small shops, the installation crew may also make deliveries.

Special precautions should be taken in transporting a receiver from the shop to the customer's home. As far as possible, it should be kept level at all times to prevent any of its parts from shifting position. To prevent its finish from being damaged, the set should be handled like a piece of fine furniture. It should be protected by quilted pads while it is in the delivery truck, and it should be held by bands or ropes to keep it from shifting around or perhaps falling over while the truck is moving.

Locating the Receiver. The location of the set inside the home is, of course, up to the customer. If he chooses a very poor location, however, you should point out the disadvantages of the location in a tactful manner and suggest a better one. Remember, if the customer gets eye strain from watching a set that is in a poor location, he will be apt to blame the set rather than its position.

In general, a set should not be located so that a bright light (such as from a window or from lamps) is behind it or near it, as at A in Fig. 7; the eye will automatically adjust itself to the brightness level of this light rather than to the brightness level of the picture, with the result that the picture will seem dark. Neither should the set be located so the direct rays of a light fall upon the face of the picture tube, as at B in Fig. 7; if they do, the apparent contrast and brilliance of the picture will be reduced, and there may be reflections and glare from the tube face and from the protective glass in front of the tube. Preferably, the set should be located so that the direct rays of any light entering the room will be

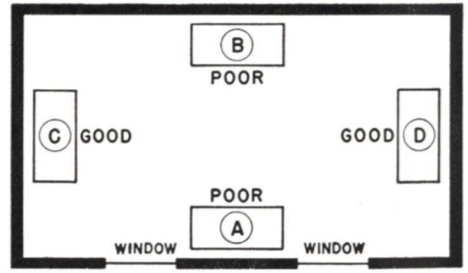


FIG. 7. Two good and two poor positions for a television set. Position A is poor because the bright light from the windows will distract the eye; position B is poor because light from the windows will be reflected from the cover glass and the picture tube.

at right angles to the line of vision of the person watching the set. Hence, from a lighting viewpoint, positions C and D in Fig. 7 are good.

To make viewing easy on the eye over extended periods of time, the room in which the set is located should be well lit from some indirect

source of light. Ideally, the surfaces near the set should be almost as brightly lighted as the middle or darker grays of the scene on the picture tube. A complete absence of other light in the room is very hard on the eyes. You should point

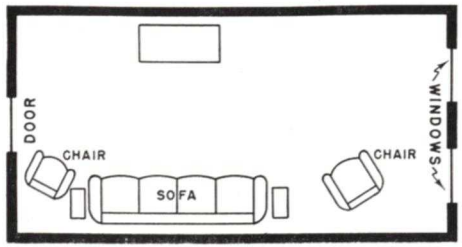


FIG. 8. A good room arrangement for watching television. All light sources are approximately at right angles to the line between the viewers and the set.

these facts out to the customer if he does not already know them.

The set should also be placed so that none of its viewers will have to watch the picture at too great an angle. A typical good location both from a lighting and a seating viewpoint is shown in Fig. 8. People sitting on the sofa or the chairs have a good view of the face of the set. If the set is a projection type, which has a rather limited viewing angle, the chairs may be a little too far to the side in this arrangement. If so, they can be brought nearer the set and pulled closer together without interfering with the view of the people on the sofa.

During the day, light from the windows will illuminate the room without lighting the face of the picture tube too much, particularly if venetian blinds are installed on the windows. At night, light from the adjacent room may be allowed to come through the door, or indirect light sources may be fastened on the wall in which the door is set. This arrangement is therefore good both from the standpoint of furnishing light at right angles to the line of vision and from that of placing all watchers at some reasonable angle with respect to the picture tube.

Always keep in mind the fact that many components in a set may prove unstable or may deteriorate rapidly if they are exposed to excessive heat. Since the set becomes quite warm in normal use, it should be located so that it can have enough ventilation. It should not be placed close to radiators or other sources of external heat, nor should any ventilation holes in the receiver cabinet be blocked by doilies or scarves. It should be located several inches out from the wall to allow heat to escape through the back.

If a table model set has ventilation holes in the bottom, as many do, it is best to mount it on the open-top tables offered by the manufacturer. In addition to permitting proper ventilation, such a table is strong enough to support the set. If the customer wishes to use his own table instead of the one offered by the manufacturer of his set, be sure that the table will be strong enough and that it will not block any ventilation holes in the set.

The proper height for a table model set depends somewhat on the furniture in the room. With ordinary living room furniture, the center of the tube face should be about forty inches from the floor. This is the height the tube will be if the table made by the manufacturer of the set is used. If the furniture is very low, however, the set should be somewhat lower than this so that it can be watched comfortably.

One other factor that should be considered in locating a set is the distance from the set to the chair or sofa from which it will be watched. The optimum viewing distance for each size of picture is equal to 6 to 8 times the height of the picture. A table of the best viewing distances for pictures of different sizes is given in Fig. 9. The viewing distance may be greater or less than the optimum distance, of course, but it is desirable to locate the set so that most of the seats will be somewhere near the right distance for the picture size.

Perhaps you feel that it is not really the business of the installer of the set to determine where it should be placed. Remember, however, that a television set is not like a radio receiver; it cannot be moved about a room readily, because its location is more or less fixed by the placement of the transmission line. Therefore, if it turns out that the customer is not satisfied with the location of his set, he will either call you back to change it or attempt to do the job himself—and in the latter case, he may injure the set or the transmission line. A poor location for the set may therefore result in your getting a call-back that could have been avoided if you had

SIZE OF PICTURE TUBE	OPTIMUM VIEWING DISTANCE
3"	13½"
7"	33"
10"	48"
12"	57"
16"	96"

FIG. 9. Optimum viewing distances for picture tubes of various sizes.

placed the set in a better location in the first place. If the customer has a service contract with you or your firm, he will expect you to change the location of the set free of charge. Therefore, you will be better off to see that the set is in a good location from the start.

COMPLETING THE INSTALLATION

When the set has been placed in its desired location, it should be connected to its antenna, and the antenna should be oriented to get the best possible reception. You learned how to do this in an earlier Lesson. Once the right position for the antenna has been found, all that remains to be done is to clear up any interference that is present, to make any minor adjustments needed in the set, and to instruct the customer in the use of the controls. Clearing up interference may turn out to be a big job. However, we shall not discuss it here; you will learn how to do it in a later Lesson.

As a final test of performance, check the reception on each station. The set should be thoroughly warmed up before you make this check.

There is always a possibility that some part may shift position slightly in the set while it is being carried from the shop to the customer's home. The ion trap may slip a bit, for example, if it is one of the kind that is held on the neck of the tube by a spring clamp. As a matter of fact, if the set uses this kind of ion trap, it is a good idea for you to check its position as a matter of routine. Twist it slightly and slide it back and forth a short distance to see if the picture brightness is improved by your doing so.

Customer Instruction. When the installation has been completed, you must show the customer exactly how to operate the set. If the manufacturer supplies a customer manual, see that he gets a copy. If the customer has never owned a television set before, have him tune in each station to make sure that he knows how to

adjust all the controls. Don't just show him how the controls should be adjusted—show him the effect of a misadjustment of a control, such as the fine tuning or contrast control, and then show him how to correct it. In other words, take time to make sure that the customer will be able to operate the set to his own satisfaction; you will be saving yourself a call-back or two by doing so.

As a matter of plain common sense, don't compare the performance of your customer's set unfavorably with that of other models. Even if the set is not the best one, don't mention that fact. Tell him what he can expect in the way of reception without saying that he could get better reception with a better set. Remember, he is convinced the set is a good one, or he would not have bought it.

Some customers will want to know exactly how the set works. You should do your best to tell him what he wants to know in language that he understands. If he appears to have a good technical background, you may be able to be fairly detailed in your explanation. If, on the other hand, he has no knowledge of electricity, you'll only be wasting time if you attempt to describe the operation of the set from the technical viewpoint. No matter how simple you make your explanation, however, be careful not to give him any misinformation. He may quote your explanation to his friends when they drop in to see the set; if you have misled him, and someone points this fact out to him, he will bear you a certain amount of ill will.

If you install a set during the day when there is not much on in the way of programs, it will be a very good idea for you to make an appointment to drop back some evening to see how the set sounds. Doing so will let you check up on the way the customer is operating the set as well as on the performance of the set itself.

Lesson Questions

Be sure to number your Answer Sheet 61RH-2.

Place your Student Number on every Answer Sheet.

***Send in your set of answers for this Lesson immediately after you finish them*, as instructed in the Study Schedule. This will give you the greatest possible benefit from our speedy personal grading service.**

1. Why is it important that metal picture tubes be handled only by their metal rims?

2. What is the purpose of the two flags on the gun structure of many electromagnetic picture tubes?

3. Why is it necessary to see that the two small wire loops at the front of the cushion that supports the neck of an electromagnetic glass tube make good contact with the conductive coating on the funnel of the tube?

4. What adjustment should be made if the retrace lines are visible in a picture that is otherwise good?

5. What is the effect on the picture of setting the contrast control too high?

6. Why is it necessary to adjust the ion trap at once when the set is first turned on?

7. How can you square the picture with the picture-tube mask for: (a) an electromagnetic tube; (b) an electrostatic tube?

8. If one corner of the picture or raster on an electromagnetic picture tube is heavily shadowed, what control or controls need adjustment?

9. Why is it unwise to place a receiver with its back very close to the wall?

10. What rough rule is used to find the approximate optimum viewing distance for any size of direct-view picture tube?

Be sure to fill out a Lesson Label and send it along with your answers.

TEN SUGGESTIONS

I. Accept and welcome fair criticism.

II. Don't be a chronic grouch or petty complainer.

III. Develop a "we" and "our" attitude toward your company. Realize that what hurts company business hurts you also.

IV. Hard work brings success just as fast today as ever. Remember this—if you never do more than you're paid to do, you'll never get paid for more than you do.

V. Prepare yourself to handle the work of men above you. A good understudy is valuable.

VI. Always be ready to do new tasks.

VII. Develop confidence in your abilities, but avoid over-confidence.

VIII. Keep your head when the routine of work is varied or when an emergency arises.

IX. Don't bury your nose in the details of your job. Assign routine duties to your assistants, so you will have time for more important things.

X. Devote a few minutes each day to clear thinking about your job, your future and your company's future.

J. E. Smith