1957 EDITION

PDC 50¢

TV REPAIR MANUAL

SNOW

Special Section on

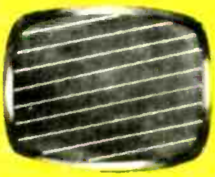
COLOR TV

NO PICTURE

For every TV owner!

SMALL PICTURE

SHADOW IN CORNER



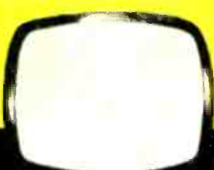
DIAGONAL LINES

by Edward A. Campbell

VERTICAL DISTORTION

- Tells you how your TV set works
- Pinpoints the trouble, pinpoints the cure
- Shows how the trouble looks on your screen
- How to spot and replace a bad tube
- How to select and install the best antenna for your set and location
- How to eliminate interference
- How to improve the sound on your TV set
- What you should know about service charges

WAVES



TOO LIGHT

This book will tell the average set owner how to make his own adjustments and repairs 75 % of the time that trouble develops

TV REPAIR MANUAL

A complete guide to the operation,
maintenance and repair of a television set

by Edward A. Campbell, I.R.E., A.E.S.

HARRIS PRESS New York 14, N. Y.

Printed in the U.S.A.

Contents

INTRODUCTION

Why This Book Can Save You Money

Mr. Raibourn

chairman of a newly constituted finance committee.

CRT Replacements In '56 Seen 6 Million

SCHENECTADY, N. Y., Dec. 29. About $300 million will be spent by Americans to replace picture tubes in 6 million TV sets in 1956, J. M. Lang, general manager of the General Electric tube department, said today.

He said that 150 million of the smaller vacuum tubes in TV and radio sets would be replaced. Noting that these replacement figures are normal in view of the industry's growth, Mr. Lang said that 5 million replacement picture tubes were sold in 1955.

NEW PROGRAM

CHICAGO, Dec. 29. — Crescent Industries, Inc., is work-

ibution and mer-

WHAT are *your* chances of avoiding TV trouble this year? The news item reproduced above very clearly indicates the odds. One out of every six TV sets in use today will need a new picture tube in 1956; one out of every 4½ sets will need one or more of the smaller tubes.

If you like to gamble, and if you have not yet had a new picture tube in your TV set, the odds are 1:9 that you will need one if your set is 1 year old; 1:6 if it's 2 years old; 1:5 if it's 3 years old; 2:5 if it's 4 years old; 3:5 if it's 5 years old and 19:20 if it's 6 years old. The odds that you will need one or more of the smaller tubes are considerably higher—against you.

There is another interesting piece of information for you in that news item, namely that the average cost of replacing a picture tube will be $50 in 1956. Considering that the average price of a 17-inch tube is $26 and of a 21-inch tube $33, and that the average picture tube replaced in 1956 will be 17-inch or smaller (due to the fact that 17-inch was the average size when these sets were younger), we can deduce that quite a bit of that $50 is for labor.

It's obvious that if this book could save you the cost of that labor on the replacement of a picture tube; or even the cost of labor on the replacement of one of the small tubes, it would save you many, many times the cost of the book itself.

Now that you have an idea of your chances of having TV trouble this year, the question is: will you be able to make your own repairs, with the aid of this book, and thereby save the cost of a serviceman?

With the proper information and instruction—which we will give you in this book—it is *simple* to replace a tube. And even replacing "the big tube" is not beyond the capabilities of the average set owner. Knowing *when* to replace and *what* to replace is the knowledge we hope to impart to you in this book, by means of an ingenious system which in four years has saved TV set owners millions of dollars.

But there will be times, of course, when the trouble is not in a tube, or when it is too obscure for the layman to find. We estimate, based on considerable research, that such instances account for *no more than* one-third of all TV set troubles. In other words, two-thirds of the time, the repairs are within the scope of the set owner who has read and understood and applied the principles in this book.

This book tells you what to do and when, and how to do it. It is written clearly and simply, with the complete story—step by step and profusely illustrated—so that the average layman, with no previous knowledge or experience, and without the use of a soldering iron or a circuit diagram, will understand all he needs to know to get the most out of his TV set . . . to operate it properly, adjust it, recognize troubles, and know whether they are due to reception or to the set itself . . . will tell him all he needs to know about antennas in order to get the best possible reception, to install them and repair them . . . and will tell him about tubes and how to analyze faults and make replacements.

In other words, this book will enable you to avoid 2/3 of your service calls. It also tells you how and where to buy what you need and how much to pay.

What about the other 1/3?

This book tells you when you do need a serviceman, what he should know, how he works and how much he should charge.

In addition, the book gives you up-to-the minute information on *color television* and what it means to you; *Hi-Fi*, and how you can improve the sound of your TV set; how your TV set can be "built-in" to blend with your living-room or recreation room decorating scheme; if and when you should *trade in* your TV set; and countless other interesting and useful facts.

And now, turn the page and start "getting acquainted" with your TV set.

CHAPTER 1

The Inside Dope On Your TV Set

MOST people don't know any more about their TV sets than they do about a house they walk by every day but which they've never visited: they just know what the outside looks like (and only the front, at that).

This is as it should be, for one should not go busting into strange houses; nor is it a good idea to go poking around in a TV set when you don't know anything about it . . . and especially if there's nothing wrong with it.

But you should be acquainted with the "innards" of your set and how to get at them in case the occasion should arise. So what we are going to do in this chapter is to help you get to know your TV set by means of pictures and explanations. It is important for you to have a feeling of familiarity with your set for two reasons: first, so you won't do any damage to it (or yourself) when and if you do start working on it, and second, so that you can proceed to repair it with speed and confidence and not with an air of fear and hesitation and the tedious trial-and-error process which is known colloquially as "tinkering."

The most important warning we can make at this point, and which we'll repeat from time to time, is this: don't turn a knob, change an adjustment, pull a tube or move a connection unless you have some idea in advance what effect this move will have. That's what we're here for: to try to give you the k n o w l e d g e to make *knowing efforts* to bring your set back on the beam when it goes astray. Don't just start out willy-nilly, turning everything. If you start off in the dark, your're very likely to wind up in the dark; except that the situation is likely to be worse than it was in the beginning.

How your set is put together

In order that you may get the maximum enjoyment out of your TV set, it is necessary that you know how to operate it properly and to keep it in good working order. To do these things, you must get on speaking terms with the set—understand it, know its capabilities, its limitations and its eccentricities. You will learn to respect it, and at the same time you will learn not to fear it. Let's start out by "looking under the hood."

You see your TV set as a box with a picture screen in front, and a number of knobs to tune in the picture. Of course, we all know that there are a lot of "works" inside the box.

The box (we call it the cabinet) may be wood, metal or plastic and it has a "picture window," usually of glass but sometimes of plastic, in the front. The glass is removable for cleaning and in back of the glass is a "mask" or frame which covers the outside edges of the face of the picture tube. In some Sylvania TV sets, the frame is illuminated (and called "Halolight") to eliminate the harsh contrast between the bright picture and the usually dark surrounding mask.

The control knobs on the front of the set are on the ends of shafts which go through the cabinet to the "chassis." You've heard this term before in reference to automobiles, in which the chassis is what you have underneath, when the body is removed.

The word "chassis" has two meanings to the TV technician. Strictly speaking, it is the punched metal pan onto which all tubes and parts are mounted. But more generally speaking, it is considered to mean all the "guts" of a radio or TV set, when removed from the cabinet.

The picture tube and the loudspeaker may be attached to either the cabinet or the chassis, physically, but electrically they are both connected to the chassis.

The chassis is bolted to the cabinet, usually by four or more bolts which come up through the bottom, so that it cannot slide out and so that it wil not fall out in shipping. A cover of metal, fibreboard, masonite or cardboard is

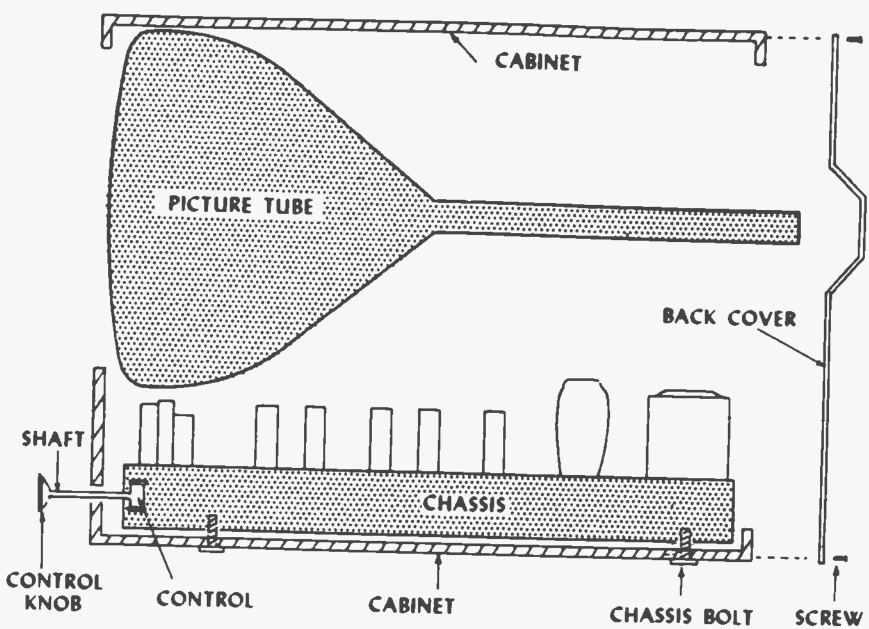


Fig. 1

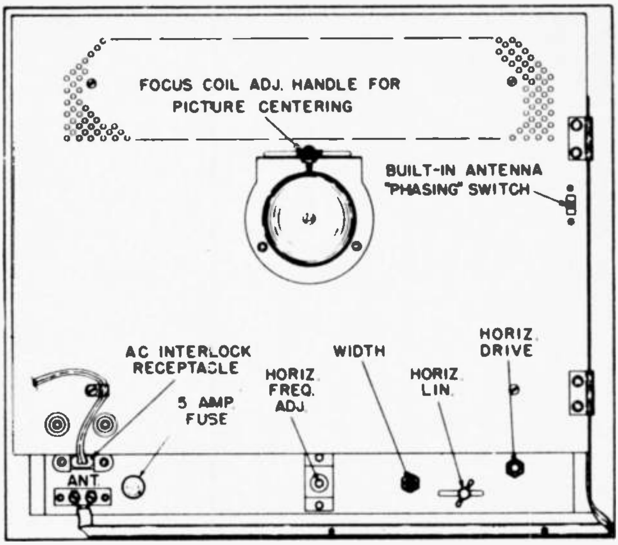


Fig. 3—The back cover must be removed to get at the tubes inside the set. The "AC interlock" disconnects the electric power from the set when the back is removed.

screwed onto the back of the cabinet, partly to protect people from the set, and partly to protect the set from people (children, and the "fools rush in" type). Usually, removing the back cover disconnects the electric power from the set, as will be explained later.

Behind the scenes

There are controls on the back of the set. These are not required for operating the set, but rather for making adjustments. They will be explained later in this chapter.

In the back there is also a place to connect the antenna, and of course there is an electric cord which plugs into the wall to supply electric power to the set.

On most of the recent large-screen sets, the picture-tube neck extends a few inches beyond the back of the cabinet, and is protected by a metal cap. This technique makes it possible to shorten the cabinet by a few inches (thereby saving a few dollars and making it possible for you to buy the set more reasonably). At the same time, this projection makes it impossible to push the set flat against the wall, which assures that it will get adequate ventilation.

Some sets will have a mechanical focus adjustment projecting out from the back cover in the vicinity of the protruding neck of the picture tube. Some sets, also, have a phonograph jack, a "local-distance" switch and other extras.

You must understand that there are naturally differences between different make sets, and even different models. Therefore, you may find that your set doesn't have something that we mention here, and you should not feel, as a result, that your set is in any way inferior.

We will explain in a moment how to get at the tubes, and how to remove the chassis from the cabinet. But first we'll explain all the controls, their functions, and how to adjust them for the best picture.

Knobs: when and how to turn them

We shall divide the controls into three categories: (1) Operating controls, which are ordinarily required for normal use of the set; (2) Non-operative controls, which are used to adjust the set for best operation and then are not again touched during ordinary operation; and (3) Optional controls, which are found on some, but not all sets.

Fig. 4—Typical set with two knobs (performing 4 functions) outside, with the others under the panel on which the name appears. This is CBS-Columbia model 22 C 88. Fig. 5, below, shows what is under such a panel.

The first thing we must do to operate a TV set is, of course, to turn it on. The *on-off switch* is usually associated with the *sound-volume control*, as it is on radios. Then we have to wait a few seconds for the set to "warm up." Next, we turn the *channel selector* to pick the station we want to watch. It may be necessary to adjust the *fine tuning control* to bring the station in the best.

If you consider the channel selector as the "coarse tuning" control, the meaning of "fine" tuning becomes obvious. The first one brings the desired station into range, the second puts it on the hairline. On some sets, the fine tuning control is adjusted for clearest sound, but on most sets it is adjusted for the clearest picture. We'll explain why this is so in a later chapter.

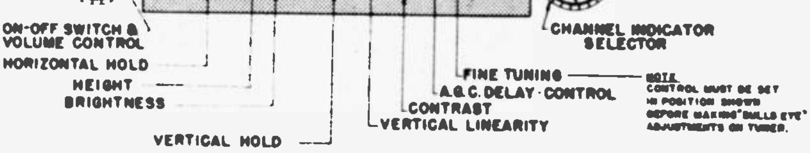


Fig. 5—Simplified front operating controls (Zenith M2237R). Adjustments in the shaded area are concealed behind a drop panel instead of being on the rear. Only controls on the back of this set are Focus, Horizontal Drive, Horizontal Linearity and Width and Centering.

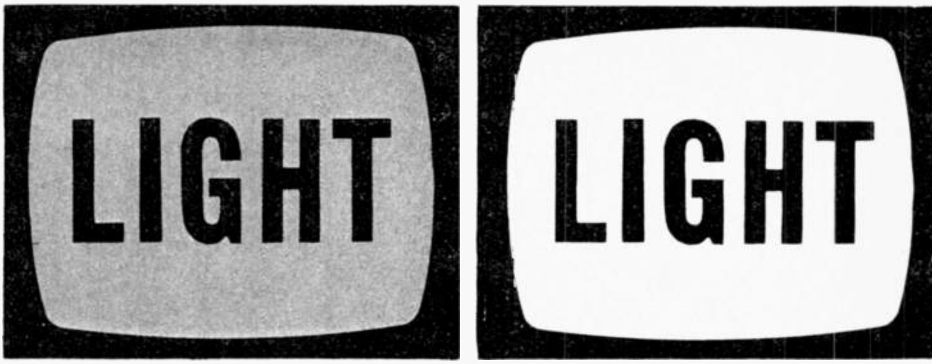


Fig.6—The whiter the whites, the blacker the blacks appear. This is the illusion of contrast.

The *contrast* (or "picture") control is to the received picture signal what the volume control is to the sound—it makes it stronger or weaker. To your eyes, this appears as making the picture brighter or dimmer. To make this clear, we ought to digress for a moment to explain just what a black and white (monochrome) picture consists of.

How black is black?

The picture you see is actually produced by light and the absence of light. When your set is turned off, the appearance of the screen is the darkest it can ever be. This is the "black" of your black and white pictures. Actually, it isn't black, as you can see, but probably gray.

Most people don't believe it when we tell them that the TV set can't *produce* black, and that the appearance of the unlighted screen is as black as they'll ever see. The answer is *contrast.*

Wherever there is a white or light area in the original televised scene, your TV picture tube is lighted. The brighter the light, the greater the contrast with the unlighted area, and the darker (or blacker) that unlighted area seems to be.

Now, to come back to the contrast control, remember we said that it is to the picture what the volume control is to the sound. We have to have this adjustment because some stations come in stronger than others. Some people like to turn the contrast (or "picture") control up as far as it will go, but you should remember this: as the whites get whiter and the blacks get blacker, the grays disappear, and the picture loses detail definition. In its most extreme condition, a person's face looks like a white blob with black holes where the eyes are.

Most sets today have Automatic Gain Control (AGC), which compensates to a certain degree for the difference in strength with which different stations are received. You might call it a "coarse contrast control," and the contrast control knob on the front of your set is the "fine" contrast control, permitting a final and more ac-

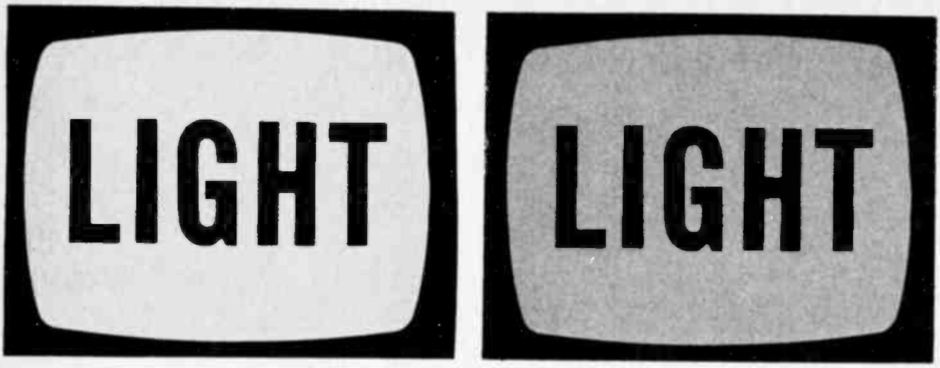


Fig. 7—The Brightness Control affects the brightness of the picture's background

curate "touch up" to the contrast. On some sets, there is an AGC switch (on the back) which adjusts the control for either city, suburban or fringe area conditions.

Setting the stage

The *brightness control* sets the background for the picture. It is a control over the operation of the picture tube in the set rather than (as in the case of the contrast control) over a signal coming into the set from the outside. You might say that it establishes the type of paper on which the picture will be painted. When turned up too high, the picture gets milky, or washed out; when too low, the picture is dim. When the brightness control is set, it should be possible to leave it that way, which is one reason why it is often not included among the primary operating controls. Some sets have an "automatic brightness" control circuit, which eliminates to a great degree the necessity for adjusting a brightness control. In conclusion we might say that if the contrast control is like a volume control, then the brightness control is comparable to the tone control. Here are the operating controls summarized:

- Primary operating controls
  - Channel (or station) selector
  - Fine tuning control
  - On-off switch
  - Volume control (for sound)
- Secondary operating controls
  - Contrast (or picture) control
  - Brightness (or background) control
- Optional operating controls
  - Sound tone control (s)
  - Radio-TV-phono switch

The non-operative controls

The fancy word, "non-operative," means that the controls we are about to explain are not ordinarily used to operate the set. They are "pre-set" controls which are adjusted for best operation and left that way. The first two, however, are sort of borderline cases. These are the *vertical hold* (or speed) control and the *horizontal hold* (or speed) control. These are synchronization ("sync" — pronounced "sink") controls, which keep the line formation and framing of the picture in step with (in sync with) the same operations at the broadcasting station. Theoretically, they should never require adjustment once they are set and in actuality, they rarely do. The ability of a set to "pull in" to sync and to "hold" in sync is a measure of its stability. It costs money to build rock-like stability into a set, and most people are willing to sacrifice a little stability in order to buy a set cheaper.

When sync tubes have aged badly or become defective, nothing will pull the set back into sync. The results are shown in the accompanying illustrations. We had occasion recently to visit some people and found the TV set turned on in the living room but nobody watching it. It was displaying a magnificent case of bad horizontal sync. The lady of the house explained that they wanted to watch a program that evening and were leaving the set on because it takes two or three hours for a picture to form!

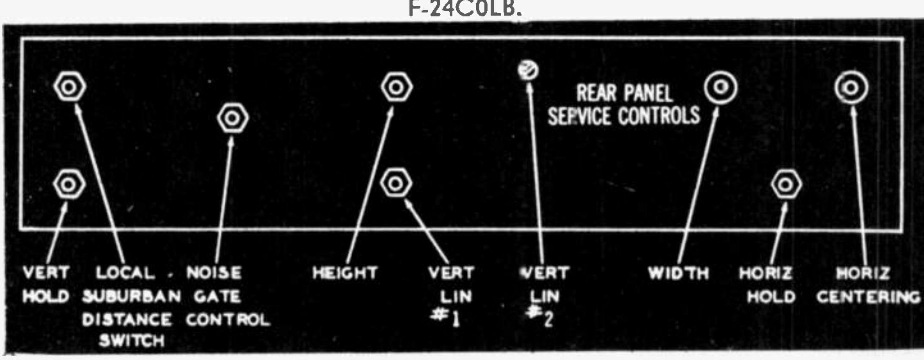
Most people don't have that kind of patience, and would either have the set fixed or fix it themselves, which we explain how to do later

Fig. 8—"It was displaying a magnificent case of bad horizontal sync!"

on in this book. Most of the other non-operative controls affect the size, shape, position or sharpness of the picture, except the AGC control, which we have already discussed. Here is a list covering almost every function one is apt to find. We must repeat, however, that you shouldn't feel that there is anything inferior about your set if one or more of these is missing, or has a different name, since there are as many variations in TV sets as there are manufacturers:

Non-operative controls
- Horizontal hold (or speed)
- Vertical hold (or speed)
- Height (or vertical size)
- Width (or horizontal size)

Fig. 9—Typical rear apron adjustments. These are found on the Crosley model F-24COLB.



Vertical centering control
Horizontal centering control
Focus control
Vertical linearity control
Horizontal linearity control
Horizontal drive
AGC (or threshold) control

The long and short of it

The relationship between "size" and "centering" is not understood by many set owners. This is shown in the accompanying illustrations, but should also be obvious when there is considerable writing on the screen (as for instance, the cast of characters in a movie). When there is a dark band along one side of the picture (or along the top or bottom) AND at the same time the print is cut off at the opposite side of the picture, then it is off-center. Left and right positioning is, of course, horizontal centering, while up and down positioning is vertical centering.

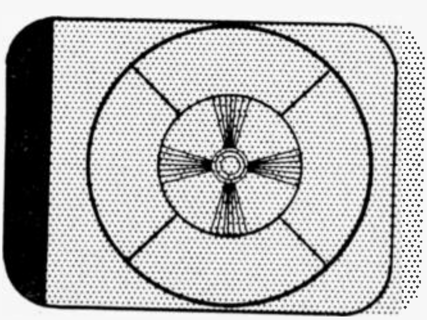
When the picture is too small, on the other hand, any attempt to center it will produce a dark band (or blank space) on *both* sides.

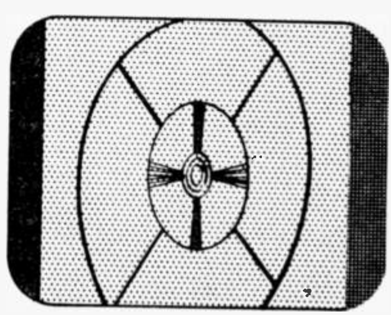
Earlier TV sets accomplished centering electrically, and had knobs on the back of the set to adjust the picture position. In most of today's sets, however, positioning is accomplished physically (or mechanically) by means of set-screws or levers which move the neck of the picture tube or the components around it. Focus, also once accomplished only electrically, is now more often achieved mechanically. There is an interaction in some of these mechanical adjustments which make a compromise necessary. This will be shown in more detail by means of illustrations a little later on.

Egg-heads vs Fatheads

"Linearity" is rather easy to understand when you inspect the accompanying drawings, but it is most often m i s s i n g from the average home TV set. A picture is *linear* when it is *in proportion* over its entire area. Most viewers can tolerate a certain amount of non-linearity, especially with unfamiliar subjects (who knows— the

Fig. 10—The trouble with the picture at the left is misadjusted horizontal centering, while the picture at the right is too narrow.





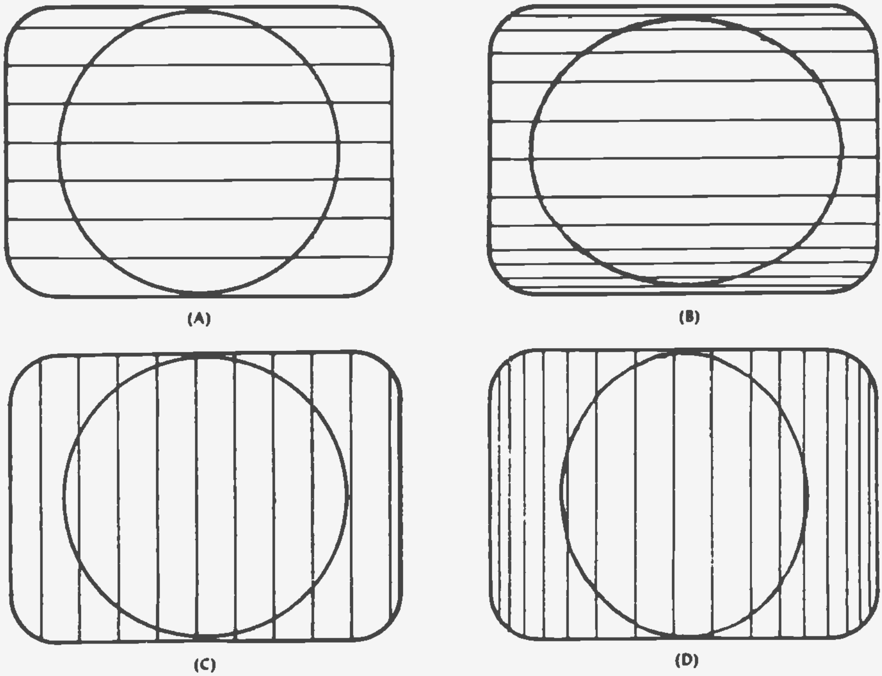


Fig. 11—"A" and "C" show perfect linearity. "B" has poor vertical linearity, while "D" has poor horizontal (side-to-side) linearity.

announcer may really be an egg-head!) but extreme cases are very annoying.

In the illustrations, view "A" and view "C" show perfect linearity. That is, the up-and-down distance (A) between each pair of lines is the same as between every other two, and the side-to-side spacing (C) is equal between all pairs of lines.

View "B" shows crowding at the top and bottom and a corresponding spreading out in the middle (poor vertical linearity). This would make people appear "moon-faced" and short and squatty in stature. View "D" exhibits crowding at the sides, with corresponding spreading out in the middle (poor horizontal linearity). This would produce the "egg-head," or tall, thin people.

View "E" shows a "test pattern," a stationary pattern of lines, circles and tone gradations, which is the best sort of picture to have

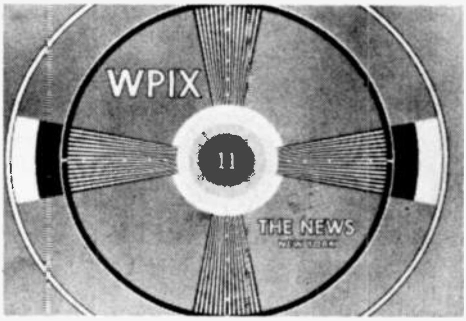


Fig. 12—Perfect "test pattern"

on the screen when making adjustments. Now that programming extends from early in the morning until late at night, however, test patterns are hard to come by. If you don't know already, you might call your local station (or stations) and ask when they display a test pattern. It is virtually impossible to adjust the size and linearity on a program in which the picture is constantly changing, and we would strongly recommend that you don't try it. When you hear how these controls operate, you'll see why:

You can't have one without the other

Height (vertical size), width (horizontal size), vertical linearity, horizontal linearity, horizontal drive and—to a certain extent—centering are all controls which are somewhat dependent on each other. For instance, if you reduce the height, the picture will get wider, and at the same time perfect linearity will be destroyed. So if, during a program, you notice that the picture is cut off top and bottom and you decide to adjust the height, watch out or, as Jimmy Durante says, "You're liable to throw the whole band into tune!"

Here is the description of the action of some of these controls from a manufacturer's service notes on a particular set (this description is not exactly the same for every set, of course): "counter-clockwise rotation of the horizontal linearity control causes the second quarter of the picture to stretch and the first quarter to crowd; clockwise rotation of the horizontal drive control increases picture width and crowds the right-hand side of the picture and stretches the left side; clockwise rotation of picture width and causes the right-hand side of the picture to stretch slightly."

We do not bring up these facts to confuse the reader. This is what actually happens and we bring it up so you can see what we meant in the beginning about not turning anything until you first know what you are likely to achieve by it. If your screen is dark, turning the height control won't bring in a picture. If the picture is rolling and the vertical hold control won't stop it, neither will any other control. These seem like simple admonishments but we've seen so many examples of people twisting everything on the set in a desperate attempt to bring in the championship boxing match, we felt it would be worthwhile to mention them.

Look sharp

Focus should be more or less obvious, being the electrical equivalent of what we do with a camera, a telescope or a pair of field glasses to bring the picture into sharp definition—to "look sharp." There is one fact to bring out in this respect, however: poor reception can produce a blurred effect similar to poor focus. But focus can be checked without reference to the picture itself. It can be checked on the line structure of the picture, which can be seen when you are very close to the screen (a few inches away). If the focus control is adjusted for maximum sharpness of the lines, then it is at its

Fig. 13—Poor linearity on your TV set resembles the distorted mirrors in the "fun house" at the amusement park.

best. If the picture is still not clear, something else is at fault, which will be covered in subsequent chapters of this book.

As we pointed out a while back, centering and focus are accomplished mechanically rather than electrically on many sets. In some sets there is no focus adjustment at all (those with what are called "automatic focus" picture tubes). On sets with a mechanical (called "permanent magnet" or "PM") focus arrangement, a flexible shaft protrudes somewhere in the vicinity of the back end (base) of the picture tube, and can be turned to adjust focus. Such a control will usually be labelled on the back cover of the set.

Another mechanical control, not touched once it has been set at installation time, is the *ion trap* magnet. The location of this device is shown in the accompanying illustration. Not every set has an ion trap, since some types of picture tubes ("aluminized tubes") do not require one. You know how a magnet draws metallic objects toward it, and the ion trap has a similar effect on the electron beam inside of the picture-tube. When in exactly the right position, the picture has maximum brightness; when improperly positioned, it can cut off all brightness from the screen. Unless it is accidently moved, the ion trap requires no adjustment, as it is fairly secure around the neck of the tube.

Pleased to meet you!

By now, you should have become somewhat acquainted with your TV set: how it is put together, what the main parts are (cabinet, chassis, picture tube, etc.) and what the controls are and what they do.

In the next chapters, we'll get a little more familiar with it, and show you the insides. We'll explain how it works, what the tubes are, what they're for, how to get at them and how to change them, and how to diagnose trouble in your set.

But before we go on to these more complex subjects, you ought to know about a simple matter which will require your attention every three to six months, which is the cleaning of the picture window and the face of the picture tube. You will be amazed at how black things can get behind that window, and how much better the picture looks after you clean it.

A face-washing party

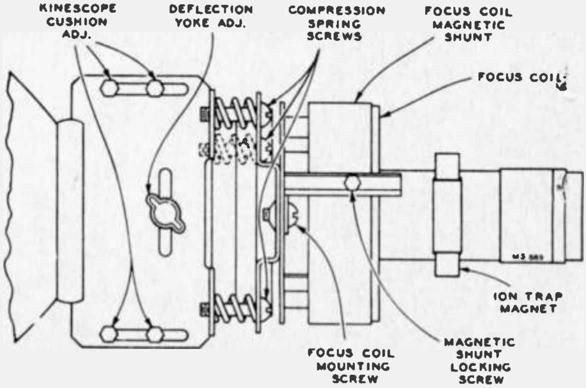
To do this, it is usually necessary to remove the glass or plastic window from the front of the set.

When the picture window is removed, it can be washed and dried just like any other window. The picture tube, however, should not be removed and need not be removed for cleaning.

Of course, you will keep the set turned off during this operation. Use a sponge or a soft cloth soaked in Tide or other detergent and squeezed out, so that water won't drip down inside the cabinet. Clean the face of the tube, wipe it off, and then repeat the operation two or three times until the rag picks up no dirt when it is wiped across the screen. Be sure to get out to the edges, so that there won't be any dirty streaks around the sides or corners of the picture. Be gentle with the picture-tube; remember, it's glass and although it is quite strong, it can be broken, just as a milk-bottle could with a sharp blow. But the consequences of breaking the picture tube are more dangerous as well as more costly. Wiping it with a cloth can do it no harm—just don't bang it with anything hard.

When the tube-face and the picture window are clean and well-dryed, put the window back in place and you're in business.

Fig. 14—Typical view from top of chassis, showing placement of deflection yoke, focus coil and ion trap.



CHAPTER 2

What Makes Your TV Tick

ONE of the most popular words today is "electronics," a word which covers the waterfront. It is hard, even for an expert, to define electronics, except to say that it covers devices which rely on *tubes* for their operation. Radio and TV sets, "electronic brains," radar equipment, Hi-Fi outfits—these are just a few of the many products today containing electron tubes. Sometimes tubes are called "vacuum tubes," because the air has been evacuated from them. Tubes in radio and TV receiving sets are called "receiving tubes." The cathode-ray-tube in your TV set is called the "picture tube" (also called "kinescope.").

Most everyone knows that there are tubes in a TV set, and when you take the back cover off your set (for instance, to clean the picture window), that's one of the first things you'll notice: lots of tubes. There are big tubes and little tubes, glass tubes and metal tubes, bright tubes and dim tubes (of course, with the back of the set off, the tubes will not be lighted).

Unlike an iceberg, most of the tube *is* visible above the surface of the chassis. On the bottom of the tube are some "pins" which plug into a *socket* which is riveted into the chassis. If you pull a tube out, you will see how this works. There is only one way for a tube to plug in, so if you do pull one out, you'll need plenty of light in order to see how to plug it back in. This is explained in the illustrations in this chapter.

In the socket are little slots to hold the pins, and at the bottom of each slot (underneath the chassis)

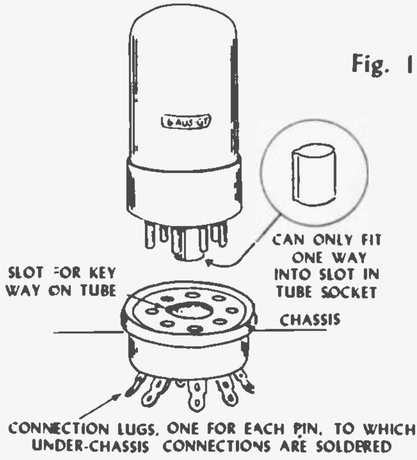


Fig. 12

are places to connect wires and other parts which connect the tube into a "circuit."

Tubes, like light bulbs, are *expected* to fail during the life of the equipment, and that is why they are made easily removable. Most tubes last at least a year or two, but this is an average; and like people, some die young and some live to a 100. Tubes are usually guaranteed for 90 days.

Unlike light bulbs, tubes don't have to "burn out" to be bad. They can be lighted and still not do their job. We'll cover this in more detail when we explain how to actually locate trouble in your set.

How your TV set works

It will make it easier to understand tubes and how they can cause trouble in your set if we give you a brief one-two-three on how the set operates.

Your antenna receives a complex "signal" which contains 4 elements: picture, sound, horizontal sync (synchronization) and vertical sync. The *tuner* or "front end" of the chassis, to which the channel selector knob and the fine tuning control are connected, is designed to select one station and reject all others (including interference) and to amplify (make stronger) the whole complex signal. From here the signal is further amplified in "intermediate frequency" (I.F.) amplifiers and eventually is separated into its 4 component parts (picture, sound, horiz. sync. and vert. sync.). These are further amplified and sent

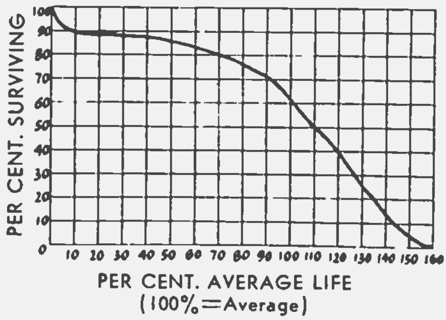


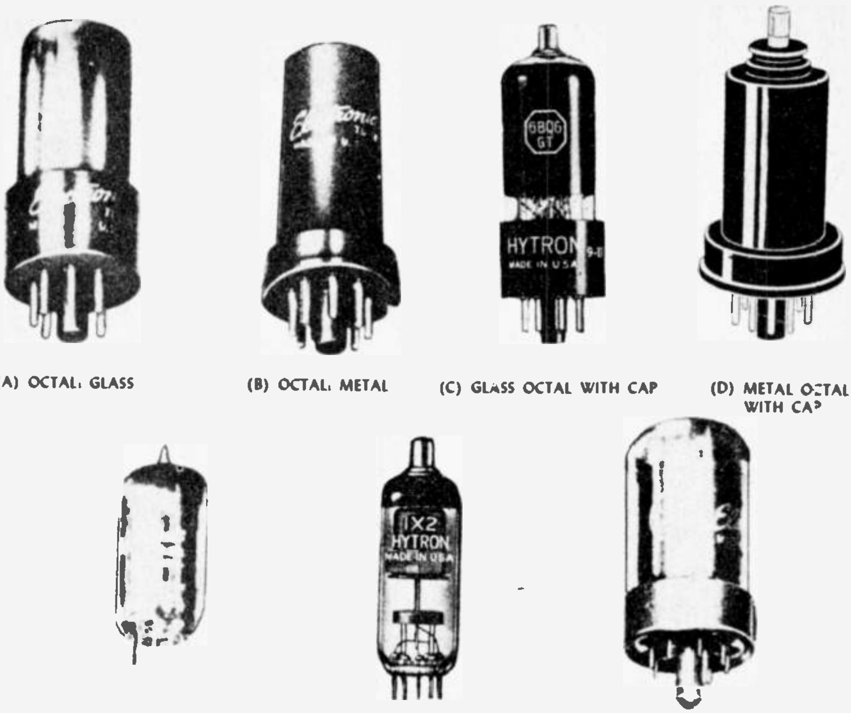
Fig. 17—This is a chart of the life expectancy of people. If the average were 65 years, then 10% of average life will be 6½ years and 140% of average life would be 91. Notice that, on this basis, 10% of the people would die before they reached 6½, 10% would still be alive at 91.

If this were a chart of tube life, and if the average life were 2,000 hours, then 10% would fail within 200 hours and 10% would still be going strong at 2,800 hours.

along to do their jobs at the picture tube or the loudspeaker.

The set has its own circuits—which operate whether a station is received or not. These include a "power supply," and many parts and tubes designed to provide the vehicle through which the various signals can travel.

It is easy to see, even from this greatly simplified explanation, that one element can be missing while all the others are present. You can have picture but no sound; sound but no picture; sound and picture but no horizontal sync, etc. It is also possible to have all the signal circuits OK, but have the power supply on the fritz, in which case nothing would work. Also, a tube or a circuit need not necessarily be inoperative: it



(A) OCTAL, GLASS (B) OCTAL, METAL (C) GLASS OCTAL WITH CAP (D) METAL OCTAL WITH CAP

(E) MINIATURE (9-PIN) (F) MINIATURE WITH CAP (7-PIN) (G) LOCKING BASE OR "LOCKTAL"

Fig. 18

might just be weak, or distorted.

Finally, assuming all tubes and circuit components to be in good operating condition, we need 2 more things: first, the set must be properly adjusted, and second, we need to have a good, strong signal coming in at the antenna. And, of course, we need a suitable antenna, properly installed and connected. Antennas are covered in chapter 4.

Getting acquainted with tubes

Since tubes are so important to the operation of the set, and since they are the most frequent causes of trouble and at the same time the easiest thing to replace, it is will to know more about them. Now that you have a basic understanding of how your set works, it should be easier to grasp the "inside story" on tubes; for you can understand that, with so many different jobs to do, there will be different types of tubes in your set, and varying demands made upon them.

Shown above are some of the most common types of tubes which you are likely to run across. Tubes are classified in many ways, and we'll take a closer look at the types illustrated to see what some of these classifications are. Incidentally, we'll omit picture tubes for the moment, since they are a subject in themselves.

First, tubes consist usually of a

glass envelope or bulb, with a base, a number of pins or prongs, and the "elements" inside which do the work. The prongs connect to the elements inside and, when plugged into a tube socket, connect these elements to the various circuits with which they are associated.

The connection of the elements of the tube to the circuits in the set is very similar to the way the filament of a light bulb is connected to the electric current in your home: through the threads and contacts of the bulb base and the lamp socket.

Like the light bulb, our electron tube also has the air removed from the inside and it also has a filament which lights up. But it doesn't light up as brightly as the light bulb, as that is not its mission in life and not as much current is allowed to pass through it. The filament of the average tube consumes about 2 watts, as compared to your average light bulb of about 60 to 75 watts. Radio-TV tubes vary, of course, with some of them consuming as much as 15 watts. The total power consumption in a TV set, incidentally, averages around 200 watts, an amount not unusual to find in a single light bulb.

7 little, 8 little, 9 little indians

Since the filament is only one of several elements in a vacuum tube, there must be more than two connections to the base, hence the many prongs, or pins. Miniature tubes have no bakelite base, as have the larger tubes, and their pins are sealed right in to the glass. Most of the tubes you will run into have either 7, 8 or 9 pins. The 7 and 9 pin tubes are the miniature tubes.

Tubes such as "A" and "B" on page 21 have eight pins, and are known as "octals," from the Latin prefix "octo" meaning 8 (octagon, octette, etc.). The tube at "C" has 8 pins, but with a special lock-in construction, so it is called a "loktal," which is "lock" plus "octal." Miniatures ("E," "F') have 7 or 9 pins. Thus we have the first classification according to type, namely octals, loktals and miniatures. Nine-pin miniatures are sometimes called "novals."

Glass and metal tubes

We said a moment ago that "tubes *usually* consist of a glass envelope or bulb." Sometimes the envelope is metal, as in "B" on page 21. Many tubes have both a glass and a metal counterpart, and the type number is the same except for the addition of "G" or "GT," meaning glass tube. Such tubes could be interchangeable but we suggest you make it a rule right now to get the exact replacement for any tube you remove, because sometimes, as we shall explain, very subtle differences in the tube type number can signify very different tubes. You can never go wrong if you always exist on an exact replacement.

So far we have classified tubes in two ways: by number of pins and by glass or metal envelopes. A third way is to classify them according to the purpose for which they are intended, such as: receiving tubes (used in radio and TV receiving sets), transmitting tubes (used in broadcasting station equipment) and cathode ray tubes (the picture tube is a type of cathode ray tube, sometimes abbreviated CRT). The homeowner is concerned only with receiving tubes and picture tubes.

Occupational specialties

A fourth way to classify tubes is according to function, as for instance, "radio frequency amplifier,' "audio frequency amplifier," etc. To fully explain these classifications would require more technical theory than the average TV set-owner would need, desire or understand, so we won't go into details here. At one time, the type number was meant to indicate the function of the tube, but this is no longer true, and it is now only an approximate indication to a person who is quite familiar with the subject.

Identification tags

The first figure of the type number, however, does signify something. This number indicates the voltage applied to the filament (the part that lights up), rounded off according to standards agreed upon in the industry.

The earliest radios were operated with batteries, so it is not surprising that some of these voltage designations are related to batteries. A typical dry-cell battery gave about 1.3 volts and a typical

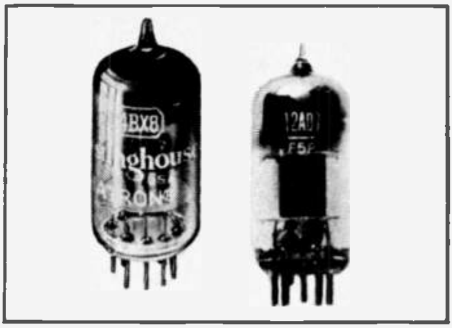


Fig. 19—Miniature tubes are smaller, have no bakelite base. The pins, or prongs, are set right into the glass.

storage battery 6.3 volts (until recently, this was the type used in most autos). Remembering that the first number of the tube type number indicates the filament voltage, we see that the 1A7-GT gets 1.3 volts on the filament and the 6V6 gets 6.3 volts. The 12AT7 takes 12.6 volts and the 50L6 gets 50 volts.

A special case are the tubes which begin with 7 or 14, such as the 7C5 or 14C5. These are the same as ordinary 6 and 12 volt tubes, but are marked 7 and 14 to indicate that they are "loktal" types.

Picture tubes are another special case, where the first number indicates the size of the tube. 17AP4, for instance, is a 17-inch tube. "P4" is found in all picture tube type numbers, and has to do with the type of phosphor which is used in them. An extra letter on the end, such as 17AP4-A, means interchangeable with the original, but has some modification, such as a filter-glass face.

The last digit in a receiving tube type number is supposed to indicate the number of elements in the tube. It is not important for the reader to know this information, except to know that it is important to get the same number as the tube you are replacing. As an example, there is no similarity whatsoever between the 6AU5 and the 6AU6. There *is* a similarity between the 6SA7 and the 12SA7, but they cannot be interchanged because of the different filament voltages.

On being a mind-reader

In the course of this discussion, it might have occurred to you to look at a tube and see what its type number is, and you just might have had some trouble reading it. Printing on glass has its limitations, and tube manufacturers have rarely used an ink or paint with a high visibility factor, such as red or yellow. And also, the numbers tend to get fainter with age. So it is sometimes difficult to read the number. Some of the techniques which have been used are: breathing on the glass, to bring the number out, and putting the tube in the refrigerator.

The best method of all for you, however, is to know what tube you took out. Most sets have a "tube layout diagram" glued inside of the cabinet of the set. From this diagram, it should be possible to identify the tubes by their location on the chassis. Then, when you pull one out, it's a good idea to write its number in pencil on the chassis beside its socket.

It's also a good idea not to take out more than one tube at a time until you are first sure that you can read the numbers on them and will know where to put them back in again.

Christmas tree lights

Most people have discovered that there are two kinds of Christmas tree lights. In the first one, if one bulb burns out (or is loose in the socket), the whole string goes out. In the second kind, the rest of the string keeps burning. The first type is called "series wired" and the second is "parallel wired." Some radios and TV sets have "series string filaments" which means that if one tube goes bad, or is pulled from its socket, the whole string gets no current and "goes out." Most higher-priced equipment is not made this way, but this is a generalization which, like every other generalization, has its exceptions.

The higher filament voltages (such as 12, 14, 25, 50 and 117 usually (but not always) indicate a series string arrangement. Many of the newer "price leader" sets have this type of tube arrangement. Since some tubes are specially designed for series string operation, this could be a fifth way to classify receiving tubes.

Finally, a tube may have a special name according to its function in a particular circuit, as for instance, "vertical amplifier," or video detector." You may find such designations on a tube layout diagram, and they can be very useful in tracking down trouble.

But don't be confused if you find that a tube type may be used in different ways, for some of them are very versatile. A 6AQ5, for instance, might act as both audio (sound) output tube and vertical output tube. A 6SN7 might be both a vertical sync amplifier and a horizontal oscillator.

For this reason, it's not uncommon to find several tubes of one type number in a set. Here's the actual complement of a 24-tube set, the Hoffman model 21M160:

1—6J6
1—6BQ7
1—6S4
2—6SN7
3—6AL5
2—12AU7
1—5U4
1—6BQ6
1—6W4
1—1B3
2—6V6
3—6CB6
2—6AU6
2—6AV6

Thus we see that, although there are 23 receiving tubes, there are only 14 different tube types. The 24th tube, in case you're wondering, is the picture tube.

The fact that the same tube can occur more than once in a set can be a useful thing to know when it comes to seeking out trouble in a set, which we will come back to in a moment. But first, it might be in order to say something about the number of tubes in a set and the way they're counted.

Most advertisements would describe the set we just mentioned as having "21 tubes plus rectifiers." The rectifiers, in this case, are the 5U4 and the 1B3. The picture tube was not counted. This is a standard nomenclature which was agreed upon by the industry many years ago because it was believed to be least misleading concerning a radio or TV set's capabilities.

Strictly speaking, a large number of tubes does not prove a set is better than one with fewer tubes. The reputation of the manufacturer, for instance, is probably a more important criterion. The year a set was made also should be considered. For instance, in 1947, the few sets which were made had at least 30 tubes. Today's black and white sets have 20 or less, and most of them work much better than those of several years ago. All other things being equal, however, the set with more tubes is apt to work better. The reason is this: when the set designer tries to cut down on the number of tubes, he must figure a way to make one tube do the work of two (or more). He might also try to eliminate a feature which is desirable but not absolutely necessary.

An example from another field would be the oil filter on an automobile: desirable but not necessary (did you know that some cars have been made without them?). Or a thermostat on a gas oven: desirable but not necessary.

So, to get back to TV, an "economy" type set with a minimum of tubes will probably operate well but will be critical of adjustment, difficult to service and will lack some refinements. Some current models, for instance, do not have a width control adjustment.

Picture tubes

Picture tubes are, in many respects, just like receiving tubes. They are of glass or glass-metal construction, they have a base with prongs, a filament and other elements inside, and they have been evacuated.

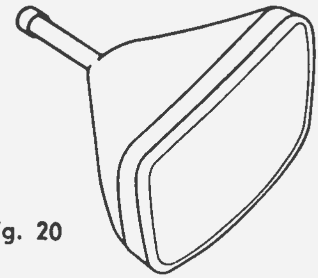


Fig. 20

The difference is that, for one thing, the picture tube is much bigger and its purpose in life is to be seen (but not heard). On the inside of the face of the tube is a coating of a phosphor which, when "excited" by a beam of electrons, fluoresces—which is a fancy way for saying that it lights up. If the electron beam can be properly controlled, we will get a picture.

The picture tube is the most expensive single component in a TV set, and most people are worried for fear the "big tube" will go dead and cost them a lot of money. However, picture tubes have stood up well, lasting 2 to 4 years, and need not cause the TV set owner to lose sleep. We mentioned earlier in this book that 6 million picture tubes would be replaced in 1956 (out of about 36 million homes with TV) but most of those will be about 4 years old and as the saying goes—don't owe their owners a penny.

If your picture tube "goes black," don't immediately jump to the conclusion that it has joined its ancestors. This is rarely the case. In the next chapter, "What can go wrong with tubes," we'll tell you some ways you can check up on yours.

Aluminized tubes

There are many special variations of the picture tube, such as the "aluminized tube" which has an aluminum coating on the inside, behind the phosphors which produce light on the screen. This tends to prevent some of the light from being absorbed inside the tube (it's reflected by the aluminum backing) and therefore produce a somewhat brighter picture. The General Electric Company has called these "daylight" tubes, but almost all other picture tube makers have a similar type. Some picture tubes have a gray filter-glass face which is designed to filter out light from the room and therefore preserve the blackness of the unlighted portion of the screen. This improves contrast. General Electric has called tubes with both of these features "black daylight tubes." These also are found in many other makes.

Deflection and deflection angles

Here, in a nutshell, is how the picture tube works: the filament heats a metal sleeve around it

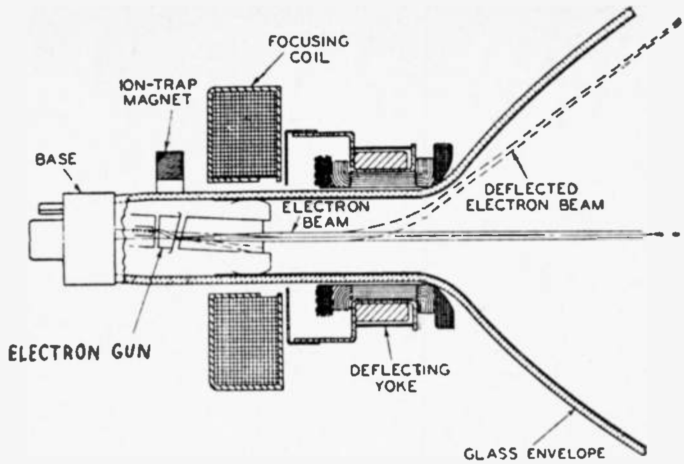


Fig. 21—The electron beam would travel straight ahead to the screen, making only a bright spot, but it is pulled from top to bottom and from side to side by electric currents in the deflection yoke.

almost to incandescence; the metal sleeve is called the cathode and when heated, it emits electrons. Electrons are negative and they will be attracted toward something more positive. This is the way ordinary tubes work, too. In the picture tube, we want the electrons to reach the screen, perhaps 20 inches away. So we "accelerate" them with a high voltage, 10-20,000 volts.

On the inside of the screen is a coating of phosphor which will glow with light when hit by electrons. Under the conditions we have established, there will be a bright spot of light in the center of the screen. Imagine that there is a stream, or "beam" of electrons travelling from the cathode (the "electron gun") to the screen. Now, if we can move this beam to the right and to the left and up and down, we can make the whole screen bright. An arrangement of coils around the neck of the tube, up against the wider cone of the tube, is called the "deflection yoke;" varying voltages on these coils, passed to them by the horizontal and vertical deflection circuits in the set, cause the beam to "scan" the tube in the manner in which one reads a book—across one line, down to the beginning of the next, across that one, and so forth down to the bottom, where we go back up to the beginning of the first one again.

A focus coil or magnet, also around the neck of the tube and just behind the deflection yoke, focuses the beam to a sharp point to improve picture definition, as in a camera.

The big end of the tube is cone-shaped, like a funnel. Deflection (sweeping) of the beam starts at the base of the funnel. For a given screen size, it follows that as the funnel gets shorter, the "deflection angle" gets greater. Earlier tubes had a 70-degree deflection angle; most present ones have 90-degree deflection; and tube manufacturers

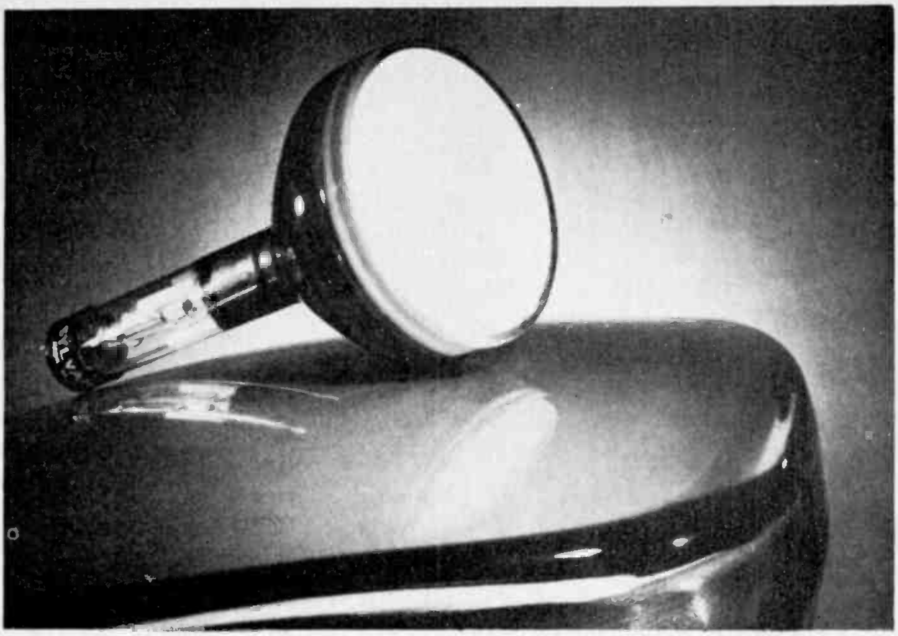


Fig. 22—At one time, all picture tubes had round faces, a considerable part of which was wasted when producing a rectangular picture. Now most kinescopes have rectangular faces.

are working on 110-degree deflection. The aim is to make the tube, and therefore the cabinet, shorter.

In the early days of TV, all tubes had a round face, and a rectangular picture was shown on it with considerable waste space around the sides. Subsequently, picture tubes with rectangular faces were developed. Now most tubes are rectangular, a few are round.

Tubes sizes

When tubes were round, the convention was built up of describing the tube size by the diameter of the tube to the nearest inch. Thus, a 10-inch tube had a round face which was roughly 10-inches in diameter. This limited the largest dimension of the picture (the width) to 10 inches (usually it was about 8½ or at the most 9 inches wide).

When rectangular tubes came out, in order to be comparable, they were sized by their longest dimension, the diagonal. In other words, we understood that the 16-inch round tube and the 16-inch rectangular tube produced about the same size picture, even though neither of them was 16 inches wide.

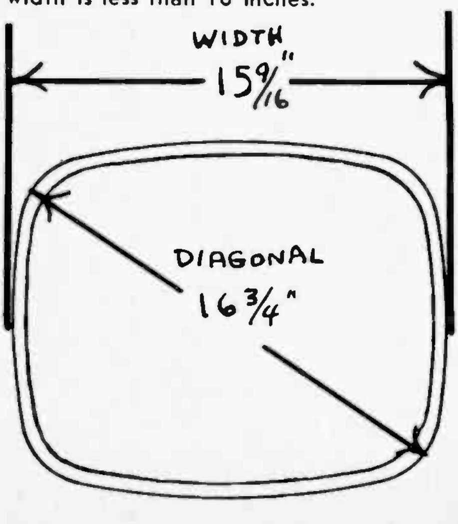
The Federal Trade Commission has recently decreed that beginning in 1956, if the size of a picture tube is not qualified, it must be the horizontal measure (width). If the diagonal measure is used, it must be clearly defined as the diagonal. If this decision is not altered, it will probably mean that the word "diagonal" will be included in all references to tube sizes, as for instance: "21-inch (diagonal) TV Set."

Virgin glass?

Picture tube manufacturers have for many years been reusing the glass bulb of old picture tubes to make new ones. They have not distinguished between old and new glass, since it has never been established that the "old" glass is in any way inferior to new. The FTC has now decreed that re-used glass bulbs must be labelled "used." We believe that this term is misleading, and that the reader may buy a tube from any of the nationally advertised brands (listed in the next chapter) without fear that the tube which doesn't have "virgin glass" is in any way inferior to those which do.

Three components can be found

Fig. 23—When measured on the diagonal, the face of this 17-inch picture tube measures almost 17 inches, but its width is less than 16 inches.



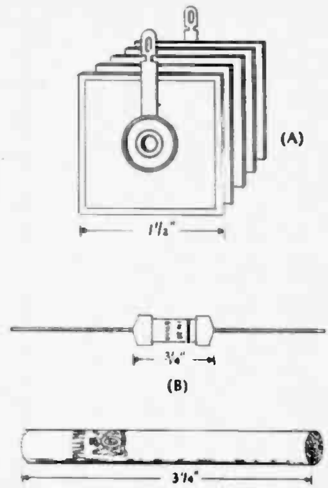


Fig. 24—(A) Selenium rectifier.

(B) Germanium crystal diode.

in sets today which do the work of tubes but which aren't tubes. These are *selenium rectifiers*, *germanium diodes* and *transistors*. The latter are the newest of the three and will probably be seen more and more in the future.

Special "tube" types

Selenium rectifiers are used in place of power supply tubes such as the 5U4, 5Y3, 6X5, 5W4, etc. Selenium rectifiers take up less space than tube-type rectifiers, have practically no "warm up" time, do not give off heat and are perfectly satisfactory substitutes in every way. The disadvantages to them, from the layman's point of view, is that you can't see if they're working. Only a serviceman can check them.

Germanium (crystal) diodes

also perform a rectifying function (changing AC to DC) and are often used in place of "detector" type tubes such as the video detector. They are similar in appearance to a resistor, are about an inch long and not quite as big around as a pencil. They are soldered in place, as are selenium rectifiers, and similarly take up less room than tubes and do not generate heat. They have the same disadvantage, that you can't see if they're working.

Transistors, newest of the electronic wonders, can perform the important function of ordinary tubes which selenium rectifiers and crystal diodes cannot, namely, to amplify. We already have hearing aids and portable radios which are entirely operated with transistors (no ordinary tubes) and we shall soon see the day, no doubt, when the same will be true of TV sets. Then we shall have a truly "portable" TV set, operating from batteries. For the present, the use of these units in TV will be limited and exploratory. Like the other two special types we have described, they will be soldered in place and will give no visible evidence to the layman of whether or not they are operating.

As we said in the beginning of this chapter, tubes are expected to fail sooner or later, and to need replacement. In the next chapter, you'll find out what can go wrong with tubes, how to recognize the bad ones and how to replace them.

CHAPTER 3

What Can Go Wrong With Tubes

Tubes sometimes "burn out," the way a light bulb does, but this is by no means the only thing that can go wrong with them and therefore cause trouble in your TV set. A burnout is another name for a blown filament. The tube doesn't light up any more, it is cold and—if it is part of a radio or TV set with "series string filaments," none of the other tubes will light, either.

But a tube can cause trouble without being burned out, since it has other elements in it besides the filament. It could be a total loss in a circuit and still be lit up and warm. Here are five of the ways a tube could go astray:

It might have a short circuit inside of it, in which case it is likely to be excessively hot and bright. In this sort of trouble, "something's got to give," and sooner or later either the tube or some part associated with it will give up the ghost.

Sometimes a tube will glow blue inside, which indicates that it is "gassy." That is, there is gas in the tube which doesn't belong there, and which sometimes is given off by some of the metal *in* the tube, or by the glass itself.

Or it may be that a tube operates weakly, as it would if it were old. Another characteristic of old tubes is that they warm up slowly. These faults may show themselves up in many ways in a TV set, whereas in radio, we were only concerned with one thing: sound. If the tubes were getting old, our radio might have taken a little longer than usual to warm up or it may just not have produced as much volume as it used to. These same things could happen in a TV set, the sound part of it, that is. But if the

Here are some defects which can cause trouble in your set:

1. **Filament burnout**
2. **Internal short circuit**
3. **Gassy**
4. **Slow warm-up**
5. **Weak**
6. **Internal noise**
7. **Microphonics**

slow warm-up tubes were in the power supply, it would take longer for a picture to appear on the screen; or if they were in the sync section (horizontal or vertical synchronization), it might take longer for the picture to "settle down." If the trouble were weak tubes instead of slow warm-up: in the power supply, the picture might not be big enough to fill out the screen; in the sync section, the picture might never "snap in."

A tube might be excessively noisy, which could show up as a hiss in the sound or snow in the picture. Snow on your screen is not usually an indication of a bad tube; more often it means poor reception (a weak signal from the station), which will be more fully explained in the next chapter, on antennas.

The elements inside a tube can, in rare cases, become loose. When these loose elements are set into vibration, the result can be a howl in the sound or interference in the picture. This trouble is known as a "microphonic" tube. Sometimes a potentially microphonic tube can be triggered into action by a tap with a pencil. Some servicemen carry a little rubber hammer to tap the tubes, watching for visible effects on the screen or noises in the sound.

One man's meat . . .

Sometimes a tube, because of a defect, will work in one place and not in another. That's why it is useful to know that there is more than one of a particular tube type in your set. It might be possible, for instance, to switch a suspected 6AQ5 in the sync section with a 6AQ5 in the audio (sound) section.

You'll remember that in the tube line-up listed in the previous chapter, there were 7 tube types of which more than one of each type appeared in the set.

It sometimes happens, too, that you might have a tube (or more than one) in a radio which also occurs in your TV set. This offers another opportunity to check a suspected tube without buying one.

Sending in a substitution . . .

If a tube is unlighted and cold, you're pretty sure it needs to be replaced. The only time when this wouldn't be true is when (this is quite rare) the circuit bringing electric current to the tube develops a fault or a loose connection.

But if all the tubes have nice healthy complexions, the trouble (like a person with TB) may be more difficult to locate. Most servicemen use the "substitution method" to check a suspected tube, which is simply to try a new tube in its place. If the trouble goes away, you've found the trouble. If not, you would recheck your diagnosis to see if it might be another tube. If no tube replacement could correct the trouble (again, a rare occurrence), you would need a serviceman to check the parts underneath the chassis.

Some people have discovered that a serviceman removed a good tube and put another in its place. In 90% of the cases, this has no significance. It may simply mean that a serviceman used the substitution method and didn't bother to put the old tube back when he found it was not at fault. He knows that since neither the old tube nor its substitute has anything wrong with it, it doesn't make any difference which one is left in the set.

Taking a tube out of your TV set and putting another one in its place is a very simple operation, complicated only by the physical difficulty of having enough room and enough light to work in. We'll discuss at a little more length later on just how to get at the tubes, but here are some ordinary, common-sense helps as a starter: get the set out from the wall sufficiently so that you have plenty of arm room; bring a lamp or a trouble light around to the back, so you can see well inside the cabinet; and refer, when possible, to a tube-layout diagram (usually inside the cabinet of the set) so you have an idea of where to find what you are looking for.

Removing and replacing tubes

Tubes are removed from their sockets by pulling straight up, the way an electric plug is removed from its outlet. But sometimes tubes resist a bit, and a little gentle rocking back and forth will help to start them on the way. But *gentle* . . . you don't want to bend the pins.

Tubes can get pretty hot when in use, and if you've just turned the set off (or if it's still on), an exploratory touch beforehand will save a burned finger.

Tubes with caps on them should not be touched while the set is on. Such tubes are rarely used now in a TV set except in the high voltage

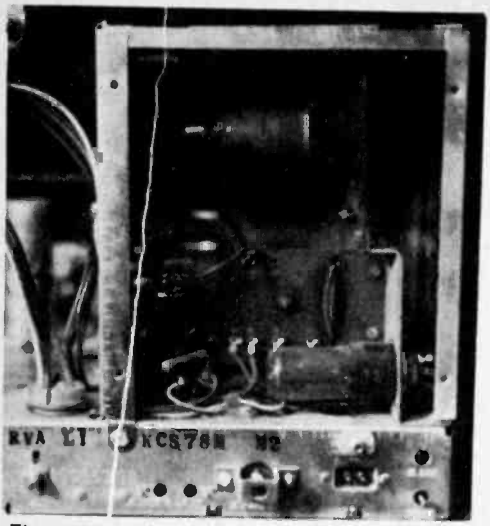


Fig. 26—The only tubes in your set which have top cap connections are usually found in the high voltage cage, or "doghouse."

section. This section is enclosed in a "cage," or "doghouse," and cannot be accidentally touched.

Tubes in the Tuner ("front end") and the I.F. section (intermediate frequency) sometimes have shields on them. These are tight-fitting cylindrical cans. They are open at the top, and you can see the tube sticking out the top (to distinguish them in your mind from other "cans" you will see, such as condensers and transformers. To remove such tubes, pull on the shield (up, possibly with a rocking motion). The shield may come off the tube, or the tube may come out with it—it doesn't matter. If the tube comes out with the shield, you can push it out of the shield with a pencil.

The important thing to remember about inserting tubes in their sockets is that they can only go in one way, and when you find the right way they'll go in fairly easily. Octals and loktals (see chapter 2) have a "key" which engages a slot in the socket. Seven and nine pin miniatures have a wide space between pins at one point (like a missing front tooth) which must be lined up with a similar gap in the holes in the socket before it will plug in.

Putting the tube back

When, because of something in the way, you can't see the socket very well, it is possible to find the key-way or the gap by holding the tube lightly against the socket and slowly rotating it until the right position is found, when it will drop in place.

When removing a tube, it's a good idea to immediately check its type number and then write this number in pencil beside the hole from which it was removed. When

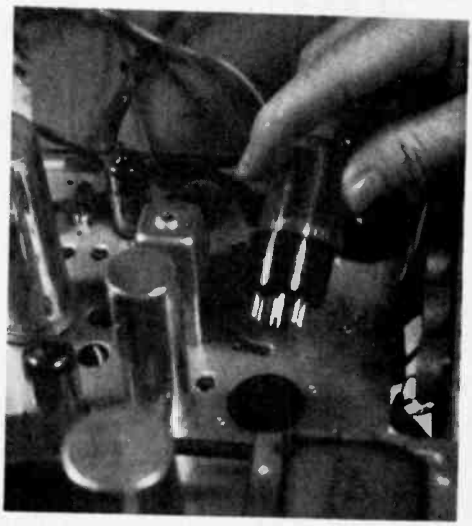


Fig. 27—Octal tubes have a locating pin on the bottom which helps to seat them properly in their sockets.

putting it back (or its replacement), always make a last-second check to see that the right tube is being put into the socket.

Which brand of tube?

We have suggested as a precept that you always replace a tube with the exact type number which you removed, but this doesn't necessarily apply to brands. All the popular brands are reliable, and the only kind of tube to be wary of is the unbranded tube—the one which has no manufacturer's name on the tube itself. Such tubes are often "seconds," or "rejects," and are frequently found on "bargain counters" where radio and TV tubes are sold.

Generally speaking, there are no bargains. If you get a nationally advertised brand such as, RCA, Cunningham, GE, Ken-Rad, Sylvania, CBS-Hytron, Raytheon, Tung-Sol or Westinghouse, you can be pretty sure of getting a reliable product. Picture tubes, in addition to these, include others as DuMont, Rauland and Thomas. Occasionally, tubes may be branded by one of the bigger set manufacturers such as Philco or Emerson, and these are equally reliable.

The Big Tube

As we said earlier, the picture tube may quit on you, but it's unlikely to, especially if it's only a year or two old. If the face is absolutely dark, first look to see if the filament is lit. This is near the

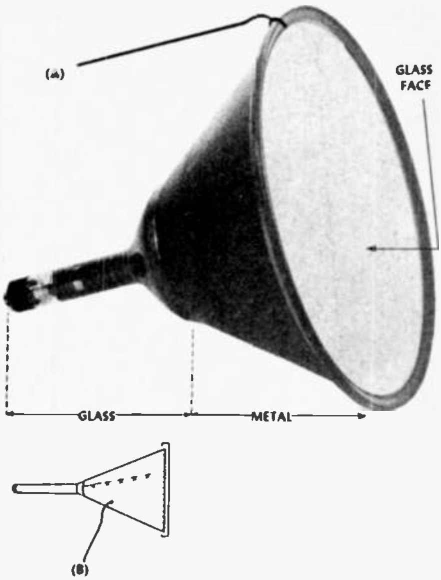


Fig. 28—Metal cone picture tube/High voltage may be connected to the lip (A) or to a snap fastener on the plastic sleeve which covers the metal (B).

base of the tube—the part that sticks out the back of the set. If the filament is lit, your trouble is apt to be elsewhere: for instance, there may be a failure of the high voltage supply, or the horizontal deflection circuit on which the high voltage supply depends.

The more common fault of aging picture tubes is low brightness. In extreme cases, the picture seems transparent.

You will hear about *tube* brighteners and tube *rejuvenators* designed to bring new life to old tubes. These will oftentimes work, and do so because they raise the voltage on the filament (of the picture tube). It is a relatively short-lived solution, however, like retreading tires. When one picture tube shows signs of approaching the end of its useful life, you might as well face the facts: a brightener isn't going to avoid the inevitable.

Removing the big tube

Taking the picture tube out of the set isn't more difficult than removing one of the small tubes, but it is usually more complicated because of the mechanical means used to hold it in. The first fact to establish is whether the tube is physically attached to the chassis or to the cabinet. Most sets today have the picture tube so securely fastened in (to prevent movement in transit) that it is easiest to remove the chassis first, even though it might be possible to remove the picture tube without doing so.

The set is unplugged and moved away from the wall, so as to have plenty of working room. The back cover is removed by taking the screws out. It may simplify things to disconnect the antenna also. If the picture tube is attached to the chassis, the chassis may be removed without disconnecting the picture tube. If the loudspeaker is attached to the cabinet (it usually is), you will see some means of disconnecting it so that the chassis can come out without it.

All the knobs have to be removed from the front of the set before the chassis is removed. The chassis is bolted into the cabinet from the bottom, and these bolts must be removed (and, of course, put back in when the set is put back together again).

In a set where the picture tube is attached to the chassis, when the back is off, the knobs are removed, the speaker is disconnected and the bolts are out, the chassis can then be slid out. Don't start doing this, however, until you have figured out where you're going to set it when you get it out. You'll find it heavy—perhaps 50 pounds—and you won't want to start hunting around for a resting place while you're holding it in your hands.

In a set where the picture tube is attached to the cabinet, you must, in addition to these things, disconnect the electrical connections from the chassis to the tube. These are usually only the tube socket on the back and the high voltage connection on the front. The latter, on glass picture, is a wire with a plug on the end which fits into a well in the tube. On metal picture tubes, the wire connects to the rim around the face of the tube.

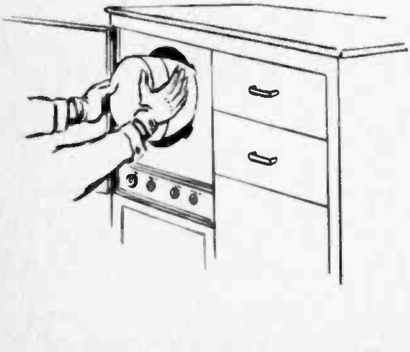


Fig. 29—Removing the picture tube.

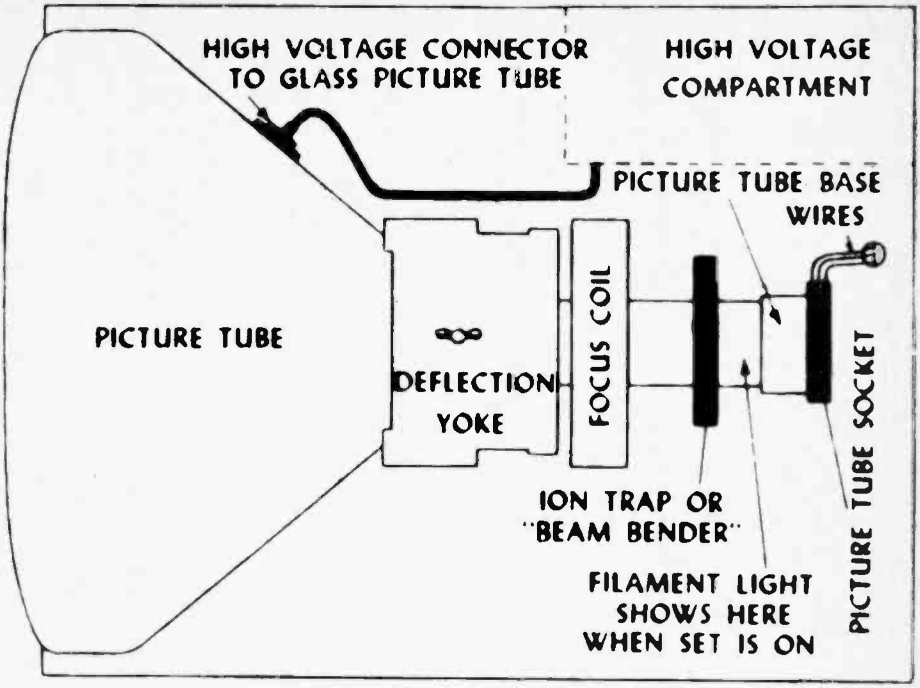


Fig. 30—Typical view from top of chassis, showing placement of yoke, focus coil, ion trap and high voltage connection. In removing picture tube, the high voltage connector and the tube socket must be pulled out and the ion trap slipped off. The yoke and focus coil stay put, and the tube slides through them.

Perhaps we should explain the distinction between glass and metal picture tubes. Picture tubes consist of 4 sections: the faceplate (always glass) on which you see the picture; the "bell," or "funnel" (which can be of glass or metal), the neck (always glass) and the base, (always Bakelite), which has pins or prongs in it like any other tube, and onto which the socket connects. So you see, it is the bell, or funnel part of the "bulb" which determines whether the tube is called glass or metal. The faceplate and the neck are fused to metal funnels just as they are to glass ones. Metal tubes are lighter in weight than glass ones. The entire metal cone (funnel) has high voltage on it and is protected by a plastic sleeve to partially protect the serviceman from shock.

"High voltage" on the picture tube means anywhere from 10 to 25 thousand volts (as compared with the 115 volts used in most of your home, for light bulbs, etc.).

Unlike tube sockets for the small tubes, which are riveted to the chassis, the socket for the picture tube is usually loose on the end of its wires, and is supported by being plugged onto the picture tube base.

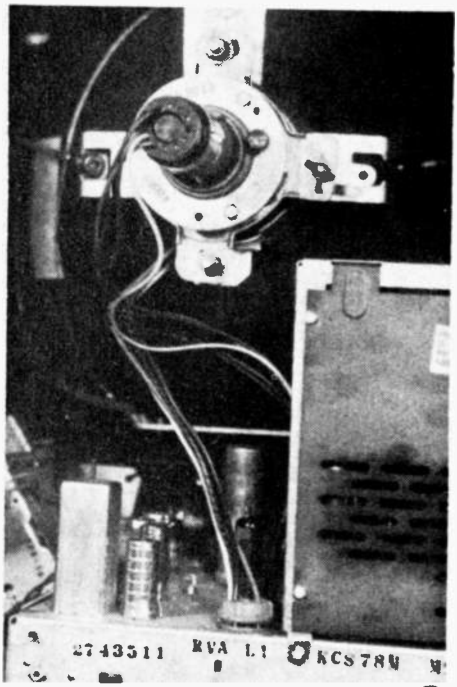


Fig. 31—The socket for the picture tube is usually loose on its wires and is supported by being plugged onto the picture tube base.

Usually it is only half a circle, since not as many pins are needed on a picture tube as on the small tubes.

Whether on the chassis or attached to the cabinet, the picture tube will be tied around its largest part (the rim around the face), usually by some sort of metal strap arrangement which must be loosened up before the tube will come out.

Finally, the neck of the tube passes through the "deflection yoke" and the focus coil or focus magnet. Usually these are fastened down on the chassis, and the tube neck can be slid out through them. If the tube has an "ion trap," this must be taken off (to the rear) before the tube can be slid out. An accompanying illustration shows the location and appearance of these parts.

The picture tube may weigh 25 pounds or more. It isn't fragile, but should be carried carefully and not banged against anything. Don't carry it by the neck; either support both the afce and the neck at the same time or cradle the big end (face) in your arms.

Handle with care

The big tube, as we said, is not fragile, but if you were to drop it, or hit it with something hard (like a hammer), the results could be disastrous. The glass encloses a vacuum and breaking it is more like an explosion than anything else. Pieces of glass are apt to fly out with considerable force with danger to anyone nearby. Persons who habitually handle picture tubes in tube factories wear heavy gloves and goggles. With ordinary care, there is no danger; but we believe the set-owner should know what the danger is so that he *will* exercise ordinary care.

As with the small tubes, you should get an exact duplicate as a replacement for your picture tube. It is occasionally possible to substitute a slightly different one—as for instance, an aluminized tube for a conventional one, where the aluminized tube is designed as a replacement for that particular tube type. But even then, there are apt to be difficulties, such as slight differences in dimensions or a

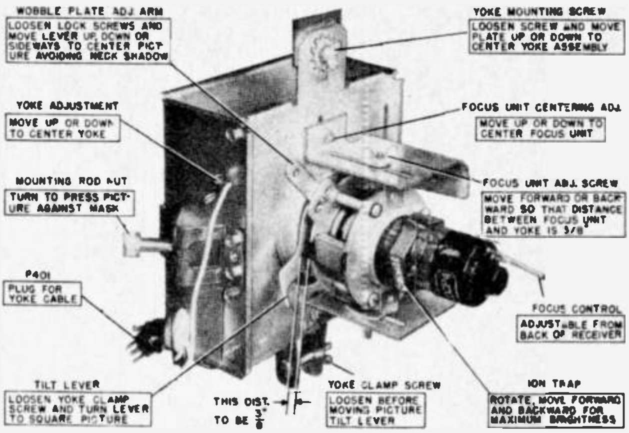


Fig. 32—Alternately turn and slide ion trap along picture tube neck for maximum brilliance of raster. Adjust P.M. focus unit to center and focus the picture and to eliminate neck shadow. Readjust ion trap for maximum brightness.

change in one of the connections. With an exact duplicate, you don't risk these problems.

Putting the tube back in place, you will slide it in through the deflection yoke and the focus magnet; will attach and tighten the metal holding-bands; attach the high voltage connector; slide the ion trap back on, if there is one; and reattach the tube socket.

If there is an ion trap, it will usually have an arrow on it, which should be on top and facing front (toward the cone). Placement and adjustment of the ion trap are explained in the accompanying illustration.

CHAPTER 4

On The Beam: The Antena Story

WITH so many sets in use today operating on built-in antennas or indoor "rabbit ear" antennas, people tend to underestimate the importance of the antenna. Manufacturers and dealers, wishing to stress the simplicity with which the sets they sell can be put into operation, tend to overemphasize the ability of these sets to operate without an "elaborate antenna installation."

But too much stress cannot be placed on the importance of the antenna in bringing in to the set a strong, clear signal. Without such a signal, the set cannot operate properly. Snow, ghosts, interference, dim pictures and unstable sync (vertical rolling and/or horizontal tearing) are but a few of the troubles which may result if a strong, clear signal is not present at the set's antenna terminals.

True, today's sets are much more sensitive than they were, for instance, 6 or 7 years ago. "Sensitivity" is the term which describes the ability of a radio or TV set to respond to relatively weak signals. Selectivity also has been improved, which means they are better able to reject interference than their predecessors.

These two factors mean that a picture can be seen in areas where *it* was once not possible to receive one except, possibly, by the use of a booster plus an exceptionally high, complex antenna rig.

What makes a good picture?

But it doesn't mean that it is necessarily a *good picture*. One explanation for this has to do with *ratios*, which we shall explain in a moment. The other reason has to do with *stability*, or the ability to stay in sync. Stability has *not*

Fig. 33

improved in the newer sets with lower prices and fewer tubes. On these sets, a good signal is needed for stable pictures (no rolling, no tearing, no jitters). And what good is a picture if it is not a clear, stable picture?

We said we'd come back to "ratios," and here's the story on them: a ratio is a relationship, a proportion or a balance. An example of such a relationship is the ratio of your income to your expenditures. If the outgo is bigger than the income, you have an unfavorable ratio. But, unlike the ratios we are about to discuss, if you "break even" on your income, you're OK. But imagine this one: the ratio between the oxygen and the carbon dioxide in the air you breathe. The oxygen has to be *decidedly* on the plus side or you'll suffocate. That's the way it is with a TV signal.

No noise is good noise

"Signal is a word used to describe the complex electromagnetic waves which come through the air from the TV station to you. Signal is to your TV set what oxygen is to the air you breathe—it must *decidedly* outweigh all "impurities" which might be present.

There are two important sources of impurity, one in the set itself and the other outside; the first is called, simply, "noise," the second "interference."

Most people are surprised to learn that SNOW is actually noise from *inside* the set—inside the tubes, as a matter of fact. Usually

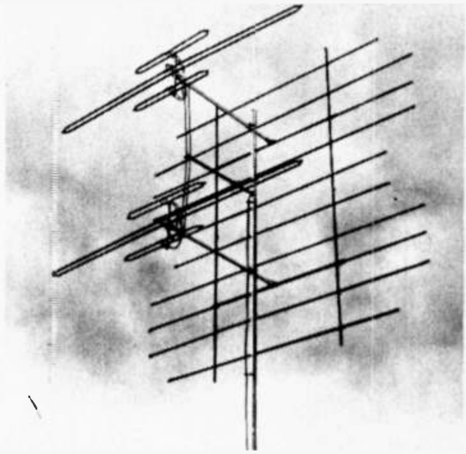


Fig. 34—A better antenna installation can often improve the signal-to-noise ratio.

people associate "snow" with long-distance, "fringe area" reception, or in other words, with a *weak signal*. The association is a correct one, but the "snow" is not picked up from the ether. Here's the explanation, and it has to do with the *ratios* we were talking about a couple of paragraphs ago:

There is a certain amount of noise inherent in the operation of tubes, but it is a very tiny amount and is very insignificant matter—most of the time. What makes it insignificant is the fact that the signal-to-noise ratio is very high, in favor of the signal. When the signal-to-noise ratio is good, noise is unimportant.

Imagine two people seated in an airplane, on the ground. They talk in normal tones and understand each other perfectly. Then the engines start up. Suddenly there is so much noise that they can't hear each other any more. That's what can happen when the noise is stronger than the signal. When the signal in your TV set drops down to such a low level that it is no longer much stronger than the noise, the noise suddenly becomes a very important factor, and you see it—as "snow" on the screen.

How to melt snow

In some parts of the country where reception conditions are very poor, snow is accepted with resignation. A better antenna installation, however, can often improve the signal-to-noise ratio.

But snow can present itself sometimes, even in fairly good reception areas—if you don't have a good antenna installation, or if something goes wrong with your antenna. For instance, it might blow down, or become disconnected, or be blown around in the wrong direction. Snow can be troublesome even in cities, within a stone's throw of the TV station, if a set is operating inside of a steel building without some means of bringing in a good signal from the outside.

Interference, also, is troublesome if it is strong with relation to the signal. Usually, instead of saying "signal-to-interference ratio," we say "signal-to-unwanted-signal ratio," because sometimes the interference can be from another TV station or from an FM station. In weak reception areas (fringe areas), automobile ignition and even such a small thing as a sewing machine motor in the next house can be troublesome (spoil the picture) if they are strong with relation to the signal. There are several ways interference can be reduced, such as with "traps," with shielding, with specially directive antennas, etc. These will be more fully discussed in a separate chapter on interference.

Antennas are not magnets

One thing you should know about an antenna is that it does not *attract* television programs the way a magnet attracts metal. An antenna is more like a butterfly net —the butterflies aren't drawn to the net; you have put the net over the butterfly. Your antenna has to be the right sort for the job, it has to be in the right place, at the right height and pointed in the right direction. In addition, it should be sturdy, and securely fastened in place, and properly connected to the set.

The strength of the TV signal in your area is one factor determining the type of antenna you'll need. Where the signal is very strong, as it usually is close to the station, a built-in antenna or a "rabbit ear" indoor antenna may be sufficient. Moderate signal strength, as in a suburban area, may be accommodated with a simple, garden variety outdoor antenna. Weak signal areas, usually at a great distance from the station, may call for a very high, very complex type of antenna.

You can get some idea of the type of area you live in, if you

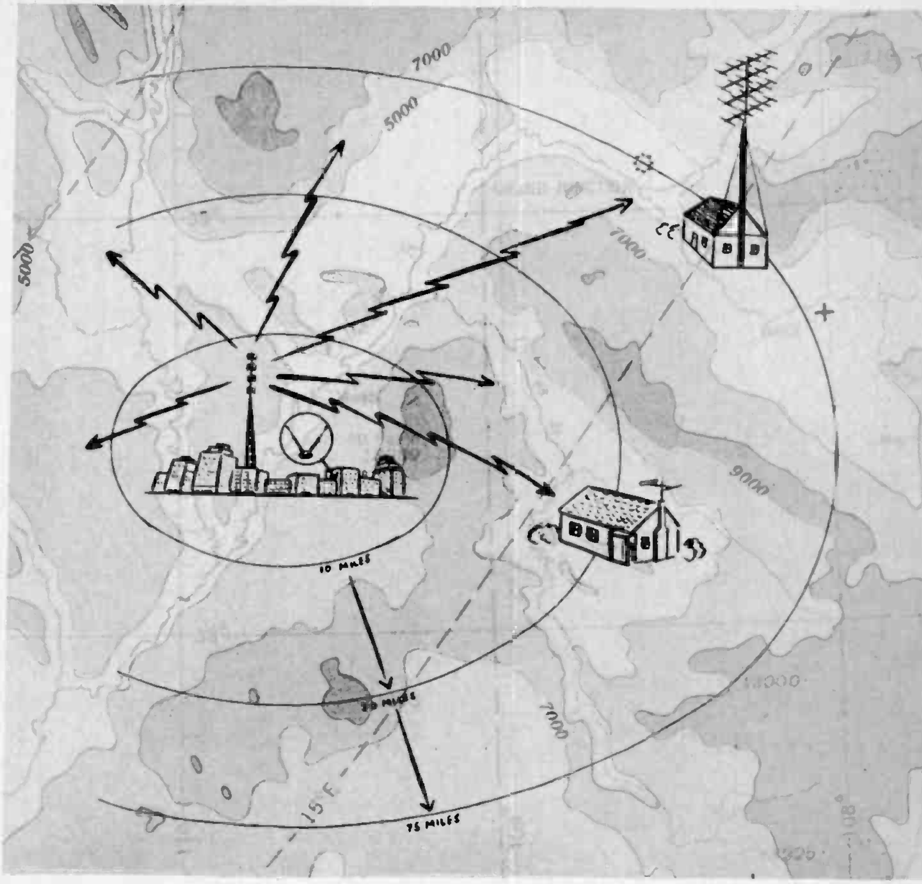


Fig. 35—The strength of the signal determines the type of antenna: inside circle is "close in," second circle is medium range, third circle is fringe area.

don't already know, by checking with your neighbors or with the dealer from whom you bought your TV set.

It is usually always the case that you can get better reception from an outdoor antenna than an indoor or built-in one. In addition, the results will be more reliable over a longer period of time, and less subject to the "rabbit ear fidgets," which is our name for constant adjustment of an indoor antenna in an attempt to get a better picture.

The basic form of all TV antennas is the "dipole," which means "two poles." The simplest form of dipole antenna is shown in the accompanying illustration. It is a rod or wire (or pole) of a certain length, with a break in the middle (making two equal pieces,

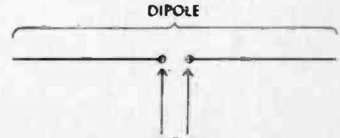


Fig. 36—Basic dipole antenna.

or poles) where the lead-in connects. The overall length of the dipole is precisely determined, and depends on the frequency or range of frequencies to be received. As the frequency gets higher, the wavelength gets shorter and so also does the dipole antenna designed to receive it.

How big an antenna?

The table shown here lists the TV channel numbers and the lengths of dipole antennas for best reception of those channels. If you have only one, or even two, stations in your area, you can get your antenna especially suited for the station(s). If you have many stations, you may have to get one which is a compromise length, to "split the difference" over a range of channels. Notice in the table that an antenna for channel 2 is over 8 feet long, while channel 14 calls for one only a foot long, and channel 83, 6 inches long.

CHANNEL	WAVE LENGTH	FRE-QUENCY
VHF LOW BAND	INCHES	MC.
2	98	54-60
3	89	60-66
4	80	66-72
5	70	76-82
6	65½	82-88
Compromise	70½	
VHF HIGH BAND		
7	32	174-180
8	31	180-186
9	30	186-192
10	29	192-198
11	28	198-204
12	27½	204-210
13	26½	210-216
Compromise	29	
UHF		
14	12	470-476
83	6	854-860
Compromise	9	

You'll notice in that table that channel 6 and 7 are *not* "right next to each other" in frequency; and also that channels 2-13 are called "VHF," while channels 14-83 are "UHF." VHF means simply, "very high frequency," while UHF means "ultra high frequency." Prior to September, 1952, we had no UHF television stations but now we have many. Reception of UHF stations usually requires more care and exactness in the antenna installation than does VHF.

Getting oriented

As you know, the Orient is the East, but we don't orient the antenna by pointing it toward Mecca. "Orientation" is TV slanguage meaning to rotate the antenna in various directions until best reception is obtained. If you could see the "beam" from the TV station, you would put your dipole directly across its path, or at right angles to it. Since you can't see the beam and usually can't see the station it's coming from, you usually have to orient the antenna and watch for best results on the screen.

We have said that the antenna should be the right size for the channels to be received, and that it must be pointed in the right direction. We have also mentioned that a simple dipole antenna may

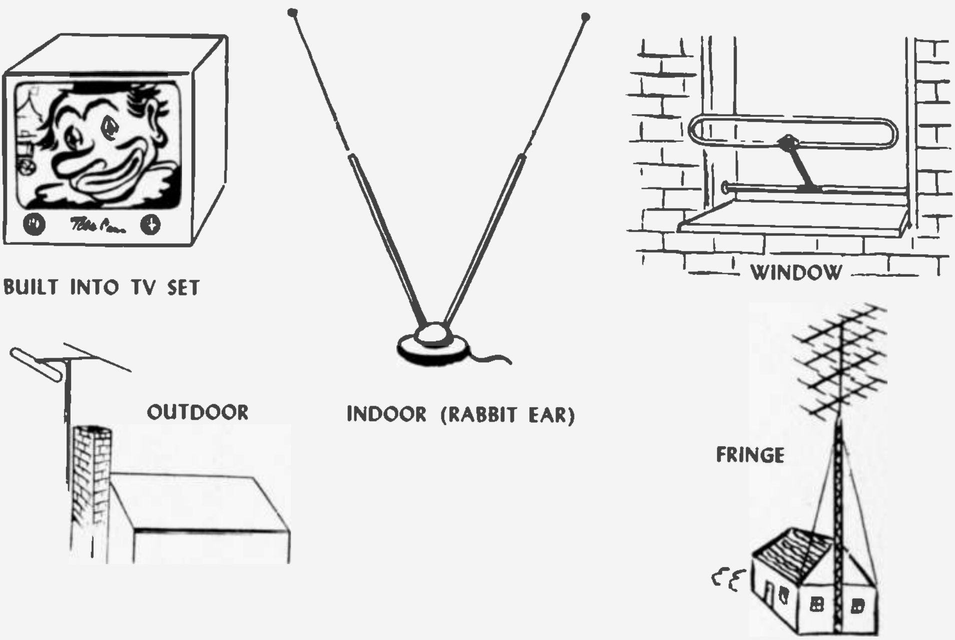


Fig. 38—The strength of the signal in your locality will determine which of these five antenna types will work for you.

be sufficient for "normal" reception conditions but that something "special" may be called for in more distant areas. What are these "special" types?

Helpful parasites

The straight dipole and folded dipole illustrated here are considered to be "single element" antennas. Multi-element antennas may have more elements in the horizontal direction ("parasitic" elements) or in the vertical direction ("stacked" elements).

A "parasite" is something which doesn't do any work itself, but lives off something else. In an antenna, the breadwinner is the part that is connected to the lead-in (or "transmission") line. The parasites, or parasitic elements, are called "reflectors" when they are on the rear side of the driven element and "directors" when they are on the front. The "front" is the side facing the station and the "rear" is the opposite end.

Unlike the common garden variety of parasites (like *fungus*) the parasitic elements of an antenna are useful. A "director" might be likened to an ear trumpet, which helps guide the sound waves

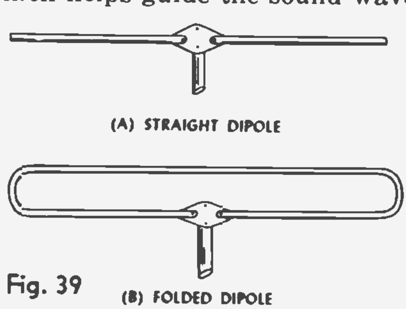


Fig. 39

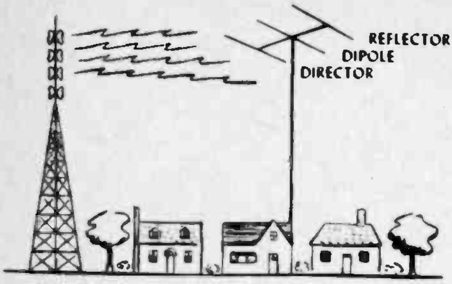


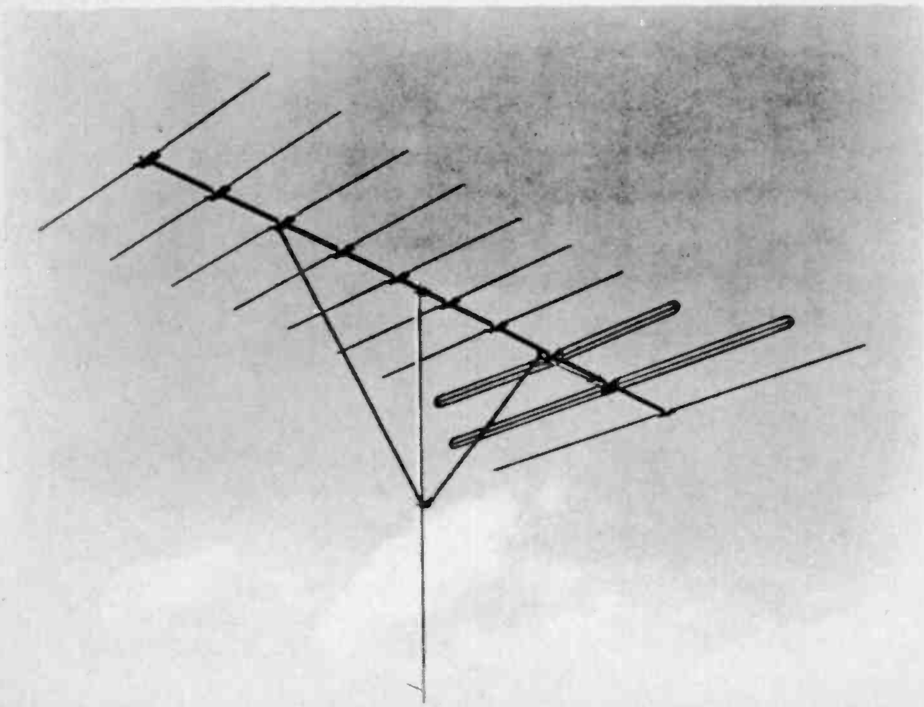
Fig. 40

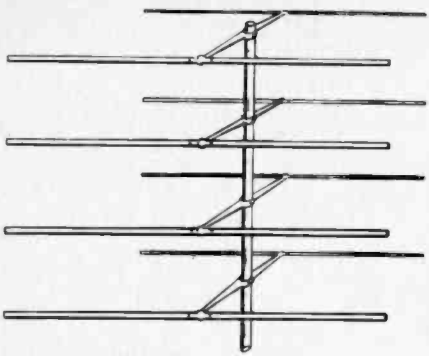
into the ear. A "reflector" is like the back-board on a basketball basket, which prevents the ball from going past the basket and sometimes bounces the ball back into it.

Almost anything metallic can be a reflector for VHF waves. For instance, a building, a bridge, a water tank, etc. But these waves are random reflections. Random reflections can sometimes spoil reception, for instance causing "ghosts" to appear on the picture. But controlled reflection by a part of the antenna can improve reception. Most outdoor antennas are furnished with a reflector. Directors characterize a special type of multi-element antenna known as a "Yagi," (YAH-GEE) after the Japanese gentleman who is said to have developed the idea

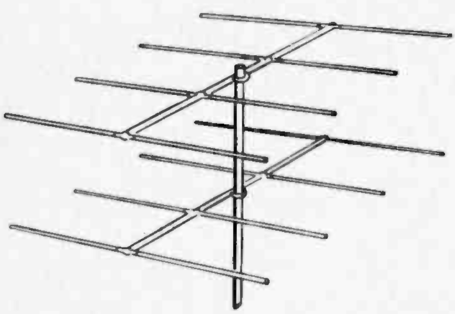
Another variation in antenna types is made by stacking antennas (putting one on top of another). We can have stacked dipoles, stacked dipoles with reflectors, a

Fig. 41—Many "directors" characterize the Yagi antenna. This 10-element Yagi made by Channel Master has a folded dipole, one reflector (behind it) and 8 directors (in front of it).





(C) 4-STACK DIPOLES AND REFLECTORS



(D) STACKED YAGIS

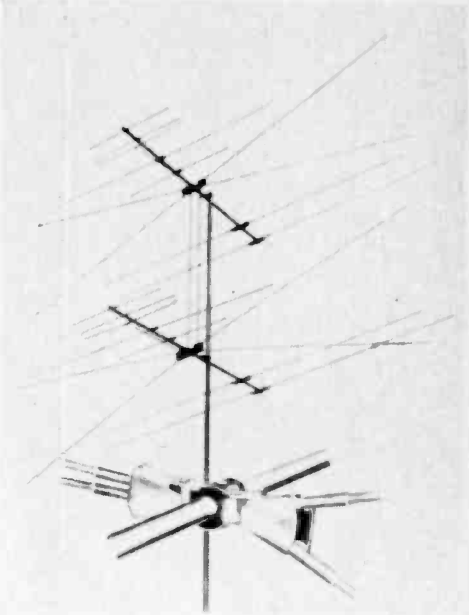


Fig. 42 (left)—Almost any type of antenna can be stacked. "C" at left is a 4-stacker, while "D" and the Channel Master Conical-Yagi in Fig. 43 (above) are 2 stackers.

4-stack (or 4-bay) dipole-reflector combination, stacked Yagi's, etc. Practically any type of antenna can be stacked, and to any number of bays, although special design data are needed to do this. In other words, you wouldn't want to try it yourself but you can buy antennas for which someone else has already figured out the problem.

A characteristic of antennas with directors on the front is that they tend to receive only in a narrow "beam" Perhaps you've noticed this phenomenon with a garden hose: in order to make the stream reach out farther, you must make it narrower. A highly directional (narrow beam) antenna has a high gain (picks up a lot of signal) but it is most useful where there is only one station to receive. A "broad beam" antenna doesn't have as much gain but is useful when trying to receive stations which are not exactly in the same direction.

Many antenna types

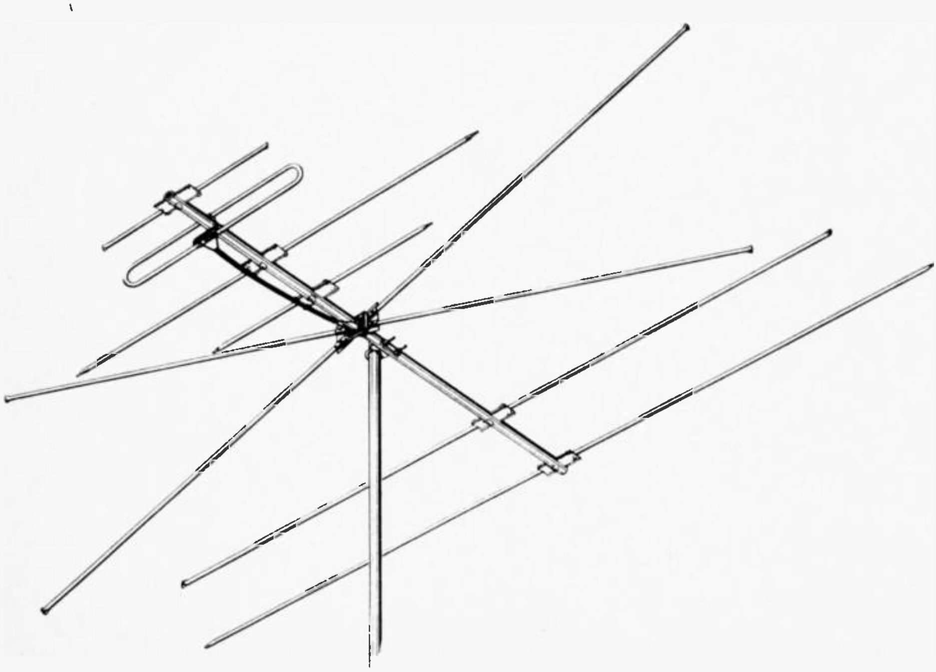
There are now hundreds of different types of antennas, from low-gain, wide-beam, broad-band types to high-gain, narrow-beam, single-channel types, with everything imaginable in between. Most any type can be "stacked," giving another set of variations on the many types available, and some antennas are stacked in both directions (crosswise as well as up and down), giving what is known as an "array," or a "bedspring" antenna. "Bedspring" and "rabbit ear" are only a couple of the colloquial names some antennas have acquired, such as "bow tie" and "V-8." You can get some idea of what is a good type for your location by looking around town to see what types are most common. The descriptive information and pictures in this chapter will enable you to identify the types and to select the type best suited to your situation, after you have found out just where the stations are, how many there are, and what channels they are on.

For a situation where it is impossible to permanently locate any type of antenna so as to receive all stations well, there are two possible solutions. First, you might have more than one antenna, with two lead-in lines, and a switch at the set to select the right one.

Rotators and dual antennas

An example of this is a certain town where there are 4 stations in one direction (due West) and one, channel 8, in another direction (slightly East of North). The separation between the two directions—about 100 degrees—is too great for a "compromise" orientation. The common solution in that area is to have a 2-stack broad-band antenna facing West

Fig. 44—A combination conical antenna and Yagi, by Clear Beam Antenna Corp.



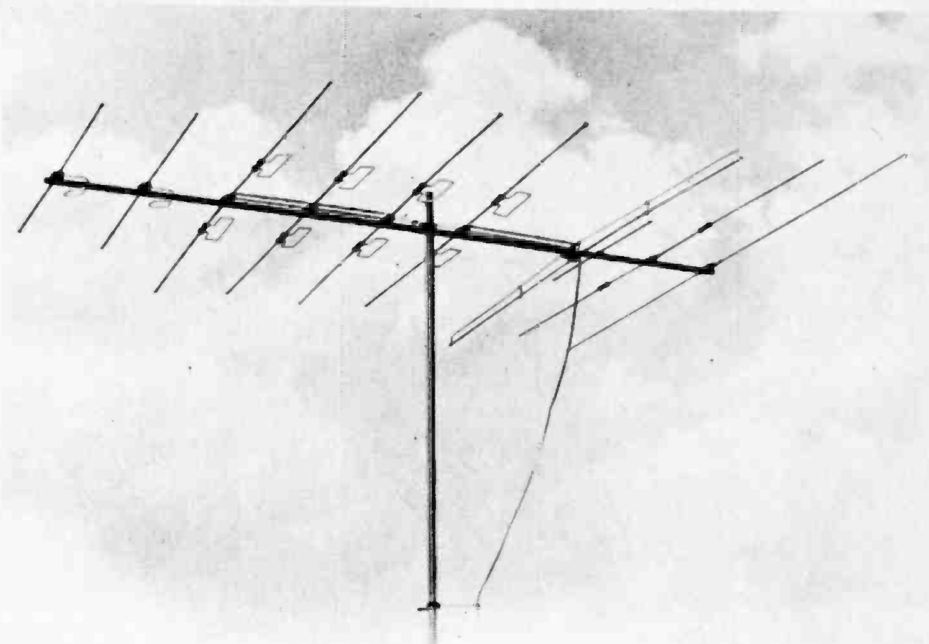


Fig. 45—The element to which the lead-in is connected is called the "driven element." Between it and the TV station are directors, while behind it is the reflector.

and a channel 8 Yagi facing toward the northerly station. An antenna switch allows the viewer to select the right antenna.

The other type of situation is where there are several stations spread over different directions. For instance, there might be one due East, one at North-East and two at due North. A compromise orientation, at North-East, would provide good reception of one station but only fair reception of the other three. A "rotator" would be the solution in such a case. This is an electric motor on the mast (the pole on which the antenna sits) which could turn the antenna in any direction by means of a remote control unit at the location of the TV set. After the channel is selected on the set, the antenna is rotated by means of the remote control until the picture is best.

A good rotator should stop immediately when you wish it to (and not "drift" by the place where you want it)and should stay locked in position after you set it (and not be blown out of position by the wind). It is also desirable to have a direction indicator so that you would know which way the antenna is pointed, and not have to rotate it through a complete circle looking for the best results.

Putting up the antenna

If you are going to use an outdoor antenna, there are many different ways possible to install it, depending on the type of antenna, the type of house or building you live in and your location with

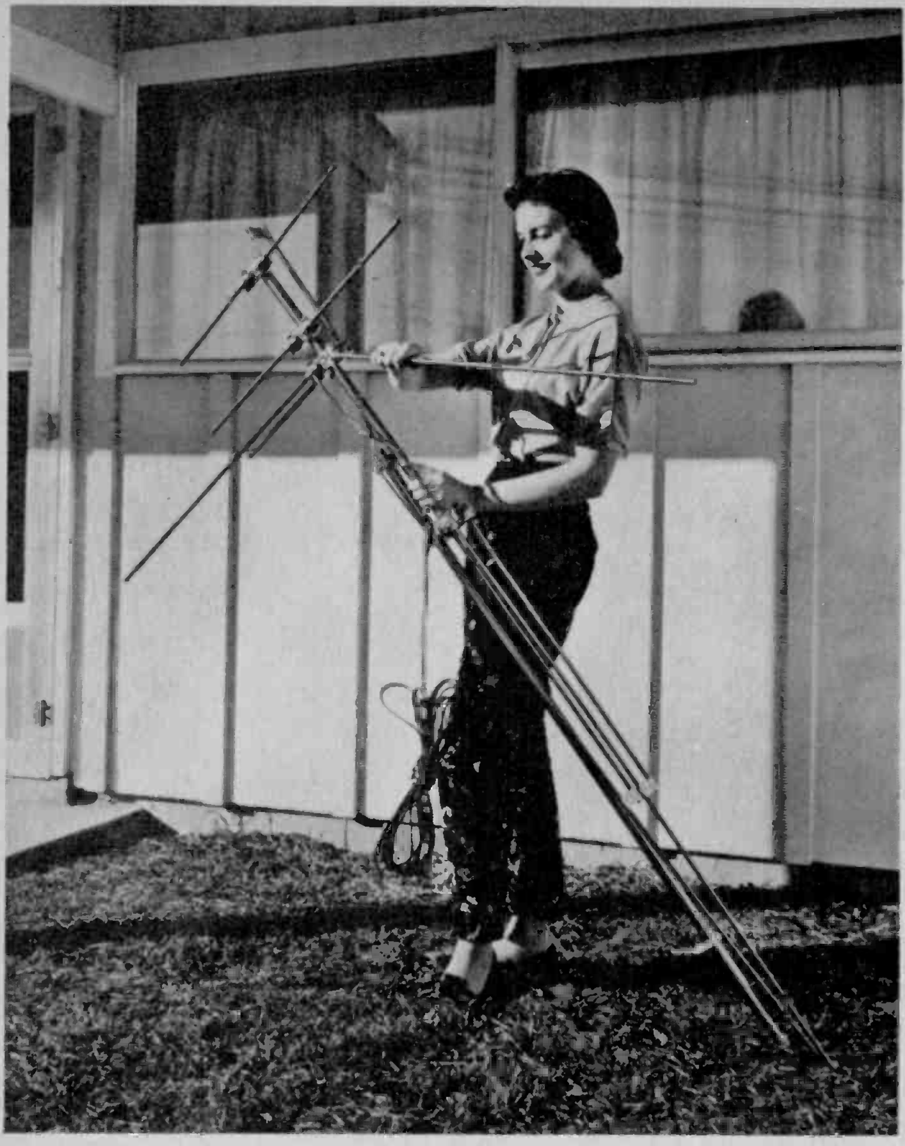


Fig. 46—First step in the installation is assembly of the antenna mast and lead-in wire to the ground, as shown in this photo by the Winegard Company. This Winegard antenna is a "jiffy-rig" type which unfolds like an umbrella.

respect to the TV station or stations. Here are the principal elements involved in the installation: the antenna itself; the lead-in, or transmission line; the mast, which supports the antenna; some kind of bracket or mount to hold the mast secure to the house or building, and in most instances, bolts or screws to secure the bracket; and "stand-off" insulators to tie the transmission line down on its trip from the antenna to the set. You should also have a lightning arrester, and you will possibly need some tacks with insulated heads to secure the transmission line to the baseboard in the house if the TV set isn't right next to the window where the line comes inside. Then, of course, you may have such extras as a rotator or an antenna switch such as we have just been describing.

We have already described some of the many types of antennas you might use. The mast is simply a pole of hollow aluminum tubing, usually 1¼ to 1½ inches in outside diameter. The mast must be sturdy enough not to fold up in a strong wind. The antenna will have a bracket built into it which slips over the mast and is tightened in place. The mast should be long enough so that the antenna is clear of the roof and all obstructions; but not over 8 feet long unless "guy wires" are used to help support it.

Height of the antenna can be important; for as you get farther away from the station, the strong TV signal (which tends to travel in a straight line out to the horizon) will be higher up in the air. Assuming a private house with a

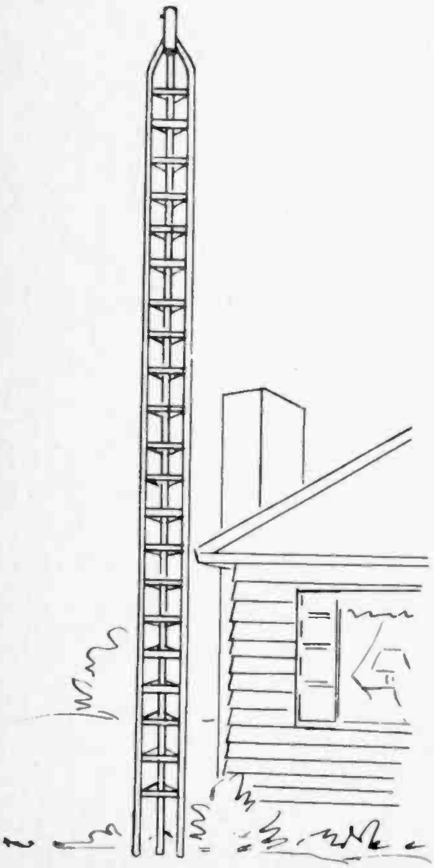
Fig. 47—One of the easiest and at the same time most secure mounts for the antenna is the chimney mount shown here.

roof 15 to 20 feet high, any mast up to 8 feet long would be sufficient out to about 25 miles. From 25 to 50 miles, 12 feet (above the house) might be enough. Beyond 50 miles 20 feet and more is customary. At great distances, it is not uncommon to put up a small "tower" on the house or next to it, with heights (overall) of 100 feet.

Assuming a "normal" installation (not a 100-foot tower), the mast may be mounted in wood or

Fig. 49—The chimney mount wraps around chimney, requires no screws to be put in or holes to be drilled.

Fig. 48—In fringe areas, it is not uncommon to put a small "tower" on or next to the house, with heights up to 100 feet.



masonry or on a chimney. Wood is easy to mount in but is the least secure, because the screws can pull out easily. The easiest and at the same time most secure is the "chimney mount." It is easy because no screws have to be put in, no holes drilled. You simply set the bands around the chimney and tighten a turnbuckle. It is secure because there are no screws or bolts to become loose and pull out, and because it has a rather wide area of support. The only thing that can happen to a chimney mount is that it can rust out and fall down. Therefore the sturdiness of the materials and the rust-proof qualities of them are important. You can buy a chimney mount for as little as $1.50, but it would be sounder to spend three or four more dollars to get the best you can find—namely, the one likely to last the longest.

There are two conductors (wires) in TV lead-in wire, and the commonest type in use is called "twin-lead" for that reason. Flat twin-lead and round twin-lead provide these two wires molded into a plastic body. "Open-wire" line finds them uninsulated (and unprotected) and held together by lucite spacers. This type is sometimes used in fringe areas because it is said to have lower losses than the other types. The fourth type of lead-in is "coaxial cable," which provides a metallic shield for maximum protection against strong interference in the vicinity of the TV set. "Coax" is also the sturdiest, but it has the highest losses of the four, is the most expensive and the most difficult to install. The twin-leads are the commonest and the easiest to handle. Flat twin-lead is the cheapest; round twin-lead is said to have the advantage that moisture will run off it more easily.

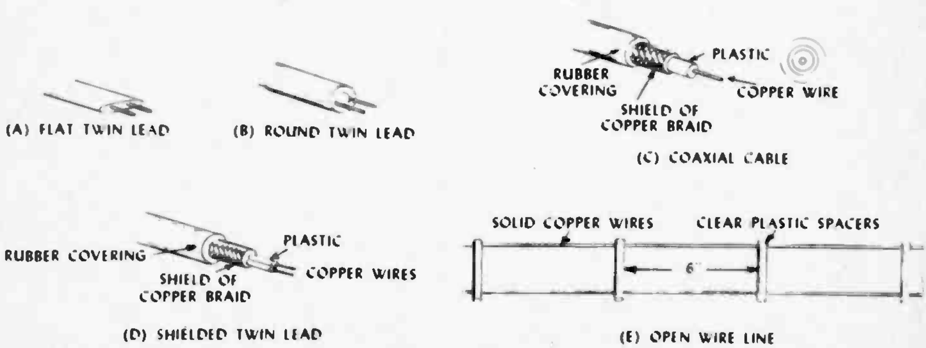
The more securely the transmission line is held in place throughout its path from the antenna to the set, the less trouble you will have in the long run. Don't have any splices in the outdoor part of the line (wind will break them loose and moisture will corrode them), but rather have one complete length of line.

Orienting the antenna

As we said earlier in this chapter, "orienting" means turning the antenna around lntil you find the spot that gives best reception. The antenna then will be across the path of the "beam" coming from the TV station, or at right angles to it.

Orientation is a job that doesn't call for a lot of scientific knowledge, but it can be a lot of trouble, especially for one person. This is because the picture could vary with a very tiny movement of the antenna, and it is desirable to see what is happening on the screen at every instant. With two people on the job — one turning the antenna and the other watching the screen—this condition can be met . . . provided they have some means of communicating with each other.

Fig. 50—Transmission, or lead-in wires.



The ideal situation is that provided by professional servicemen, who use a pair of battery-less telephones (known as "sound-powered phones") to converse with each other during the orientation process.

Although it may be more trouble, the job *can* be done without phones and it can even be done by one person—that is, a healthy one who doesn't mind running back and forth from the set to the antenna and vice versa for quite a while.

Where there are two or more stations which are not located on the same transmitting tower, it usually is necessary to find a compromise position which does a fairly good job on both of them.

Reflecting signals and ghosts

The antenna may not give best results when placed at right angles to an imaginary line drawn from your house to the TV station if your house is "blocked off" by some high building. Sometimes in a situation like this, a reflected signal can be picked up from a different direction (from that in which the TV station lies). This would be a bounce, or carom shot, as shown in the accompanying illustrations. The direct signal is blocked and the bounce signal becomes the principal one.

In the case of "ghosts," a similar situation exists, except that you are able to receive both the direct signal and a bounce (reflected) signal. The reflected signal has to travel farther, so it is a tiny fraction of a second later in reaching your screen than is the direct signal. Therefore it is slightly displaced (out of register) from the main picture. It is also a little weaker, since some of its strength was absorbed or lost in the bounce process, and consequently it looks like a ghost. Usually orientation will eliminate ghosts (they are commonest in or near cities, are very rare in deep suburbs or fringe areas). In particularly troublesome cases, a more directive antenna (narrower beam) will help. Sometimes, also, putting the antenna in a different place on the

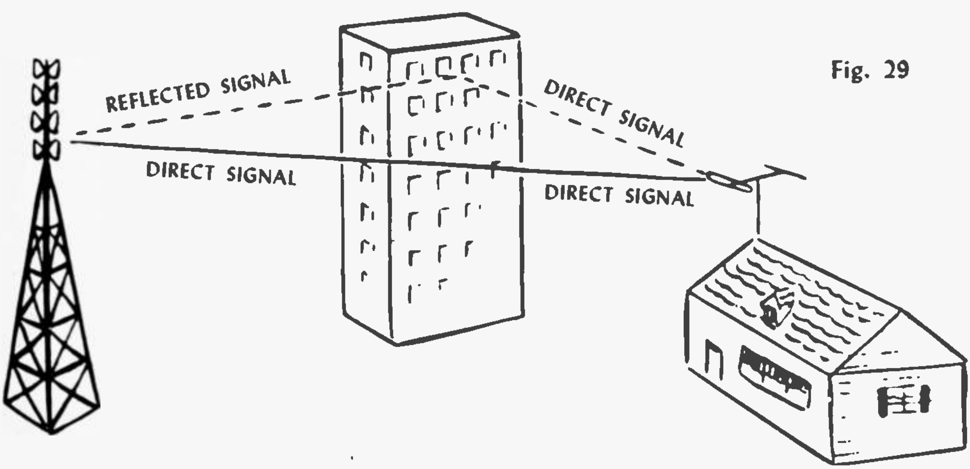


Fig. 29

roof will help.

A "fringe area" is a place where the received signal is very weak. It is usually, but not necessarily, at a great distance from any station. The best place to start in order to get good results in a fringe area is at the antenna. That is, anything you can do to bring more signal in to the set will help improve picture quality and stability. And everything you can do is apt to help (and nothing is 100% predictable). You will use a high gain antenna, such as a stacked array or a Yagi (or stacked Yagi's); you will use a high, guyed mast or tower, usually at least 50 feet above the ground; and you will see to it that every detail is attended to in the best way possible.

Fig. 52—Typical fringe area installation with 2-bay conical and high, guyed tower.

Fringe areas

Physical strength and resistance to wind and corrosion are important criteria in the choice of equipment, and no economy is effected by purchasing cheap ones.

When erecting high masts and towers, consideration must be given to the possibliity that the installation will blow down in a storm; therefore, the antenna should not be placed near enough to any electric power lines, lest it fall across them on its way down.

A self-supporting tower is preferable to a mast requiring guy wires on a very high installation, since it is inclined to be stronger as well as easier to put up. Masts have a tendency to buckle between guy wire connections, especially if the latter are too far apart.

At great distances, orientation is not usually a problem. The direction of the station is determined as a compass heading and the antenna is set that way and left. It is difficult to orient an antenna in the fringe areas in the daytime because the picture may be too dim to see. Where stations are located in different directions, an antenna switch or a rotator may be used, as described previously. A rotator, however, is a difficult item to put up and/or to repair when it is 30 to 50 feet above the roof, and for this reason is usually not employed in fringe areas.

Some locations are in the fringe area of stations located in opposite directions, or in other words, just halfway between. It even happens that you might find the same channel in use in cities in opposite directions from you.

About venetian blinds

Theoretically, an antenna with a reflector is "blind" from the rear, or reflector end. Since it receives better from the front than it does from the back, it is said to have a good "front-to-back ratio." But such an antenna is not really "blind" from the rear; it *will* pick up something. In the case we described of being halfway between two stations, it is therefore possible to pick up both of them. The resulting interference is seen as wide black bars across the picture, and is known as the "venetian blind effect." To lick this problem, there are antennas designed with an exceptionally high front-to-back ratio, effectively cutting off reception from the rear. If you live in that type of location, you may need such a special type of antenna.

How to diagnose trouble

In the course of this chapter, we have mentioned a number of troubles which can be due to the antenna (or the lack of one). When you have trouble with your TV set, the explanations in this chapter on antennas can guide you in deciding whether the trouble is in the set or outside of it, an important decision to make.

These include: snow, ghosts, radio interference, auto ignition interference, weak pictures, unstable pictures, venetian blind effect, and "flashing" pictures. These troubles are not *always* due to the antenna, but you can quickly find out if the antenna or it installation is at fault. "Flashing" pictures are usually due to a frayed or broken transmission line which makes and breaks contact as it flaps in the breeze; an inspection tour will locate this.

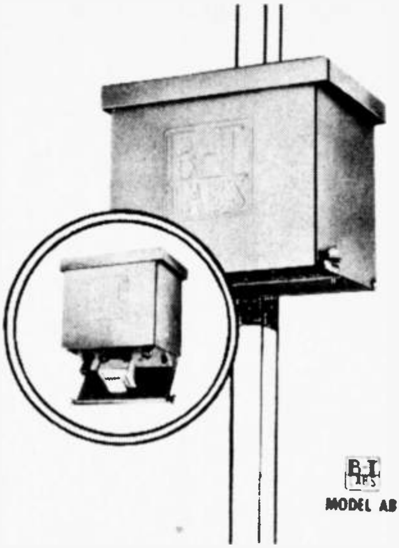


Fig. 53—"Boosters" often help in fringe areas. The most successful are those mounted on right on the antenna mast, like the Blonder-Tongue model shown.

A *change* in reception: as for instance, snow, when you didn't use to have any, suggests that the antenna has fallen down or turned around, or the lead-in has completely broken through; or possibly, that the lead-in has be come accidently disconnected from the back of the TV set.

Even the best antennas and transmission lines don't last for-ever. Two or three years is usually par (even less in very damp places, and especially near the salt water) and you should take a look at your installation every summer (or before the cold weather sets in) to see whethe rit is rusted and bent and broken; or if the transmission line is cracked or frayed or broken. Perhaps its time you did the whole job over. You'll be amazed at the improvement you can effect this way, without even touching the inside of the set.

Fig. 54—Antenna clip makes it easy to connect and disconnect ead-in at back of set (photo by Winegarc Company).

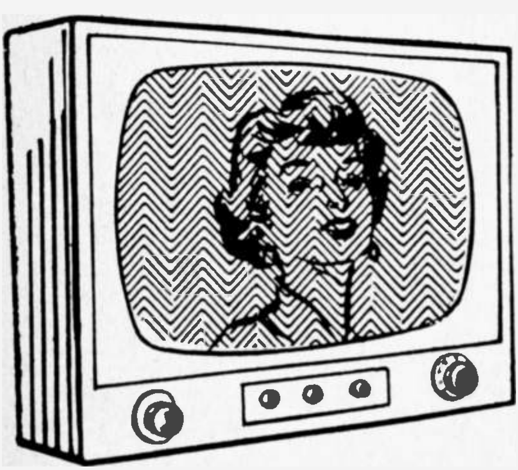
CHAPTER 5

Interference

INTERFERENCE might include anything which interferes with perfect TV viewing, such as your mother-in-law's voice, your baby banging on the set with a hammer, or your electric company turning off the juice because you didn't pay the bill.

Usually, however, the term is restricted to things which are received by the set other than the desired program. The technical term is "spurious or unwanted signals."

In television, interference can be *seen*, whereas in radio it could only be heard. Interference is not very common in radio, however. You might hear motors running, fluorescent lights humming and—especially in the country — you might hear "cross talk" from another station, or static, or Morse code. You may have noticed that interference and noises on your radio disappear or are gently reduced when you tune in a strong station. This means, as we explained in the chapter on antennas, that the "signal-to-noise ratio" is high, or in other words, good.



Television is more vunerable to interference but—like radio—it is more vulnerable when the signal is weak, or when the signal-to-noise ratio is not good. Obviously, one way to reduce interference is to improve the signal. This is sometimes possible by providing a better antenna or antenna installation (higher, better oriented, etc.).

What it looks like

Interference usually manifests itself as a pattern laid over the picture, which tends to spoil the contrast and definition in the picture. This pattern may be in the form of diagonal lines, vertical lines, a herringbone pattern, a moire pattern, etc. The "venetian blind" effect, described in the previous chapter, can be considered a form of interference. Auto ignition and electric motor interference appear like little black dashes or hyphens at random throughout the picture. Snow is NOT interference, as has been explained.

Another visual trouble which is NOT interference is a pattern on the screen which keeps appearing or pulsing in step with the sound, particularly with the voice of a speaker. This is obviously sound in the picture, which we might describe as a "leak" from the sound circuits in the set into the picture circuits. Most often it is the result of improper adjustment of the fine tuning control, but it may be a defect in one of the tubes or circuits in the set. The way to seek out such trouble will be described in the next chapter.

Sources of interference

The equivalent of "crosswalk" on a radio can be a pattern on the TV screen resulting from the reception of some source of radio frequency radiation in addition to the TV station which was selected. The source might be an FM station, another TV station, an amateur ("ham") station, a commercial communications station; or it might be radio-frequency medical equipment, radio-frequency heating equipment or radio-frequency welding equipment.

TV sets are designed to select the channel you wish and to reject all other channels and other radio-frequency signals. "Trap" circuits of one sort or another are part of the normal equipment in a TV set to "trap out" unwanted signals, under normal conditions. Abnormal conditions would exist when the source of interference is close by and/or when the unwanted signal is strong with relation to the desired signal. Under such conditions, interference becomes a troublesome pattern on the screen (occasionally you can also hear it in the sound) and we must do something about it.

Wave traps

It is possible to purchase special traps for external connection to the set. The theory of a trap (sometimes called "wave trap" or "filter") is simple. A filter is tuned to the interference and removes it in somewhat the same way that you might put dirt through a screen of such size that the holes were too small to let rocks through.

Some brands of filter are efficient and some aren't; but the best ones are only good for the situation for which they were designed. Unfortunately, it is not simple to determine what it is you want to filter out. If you get a trap which is designed to eliminate interference from FM stations and your interference is from an amateur radio operator, the chances are that you won't notice any improvement. Consequently, if you buy a trap, it would be wise to try to exact a promise that you may return it if it doesn't do any good.

In appearance, a trap is usually a little box which in size is somewhere between a pack of cards and a box of kitchen matches. It usually has four screw terminals. The lead-in wire from the antenna is connected to two of them, and an additional piece of twinlead is connected to the other two terminals and, at its other end, to the antenna terminals of the TV set. The handiest place to put it, and at the same time the most effective, is right on the back of the TV set itself. Some traps have adjustment screws which, when turned in or out, "tune" the trap for maximum absorption of the unwanted signal. The interior of the box is a simple arrangement of small coils and condensers; you pay for the ingenuity of the designer rather than the intrinsic value of the parts.

High pass filters

Traps are usually designed to accomplish one of three types of chores: (1) to trap out all frequencies below a certain frequency —this is called "high pass;" (2) to trap out all frequencies above a certain frequency—this is "low pass;" or (3) to trap out a particular frequency or narrow band of frequencies—this is the "band elimination" filter. The most common TV traps are type 1, the high-pass filter. Such a trap is designed to eliminate all medical and industrial equipment, "ham" and commercial communication equipment, which operate at frequencies below that of TV. The second most common type is type 3, the band-elimination filter. Such a filter is often designed to eliminate the FM band. A high-pass filter would not work for FM, because FM frequencies lie right in the midst of the TV frequencies, and not below them. Type 2, the low-pass filter, is not used in TV.

Other answers

The trap is the commonest and easiest method of attacking the interference problem, but it will not work in every case. There are other things which can be done, and in some cases these will help without traps. Sometimes they must be used in addition to using traps.

First, there is orientation of the antenna. Often the source of radio-frequency interference can be "tuned out" by slightly re-orienting the antenna so as to favor the desired station and slight the interfering one . . . just as it is sometimes possible to orient to eliminate a ghost.

In the case of auto ignition interference, the problem is one of closeness—the auto is much closer than the TV station. We know where the autos are: they're on the ground, in the street. We can *lessen* auto ignition interference by raising the antenna higher above the ground, and if possible, relocating it farther away from the street.

To understand the term "shielding," think literally of the knight

Fig. 56—Often the source of radio frequency interference can be "tuned out" by orientation of the antenna.

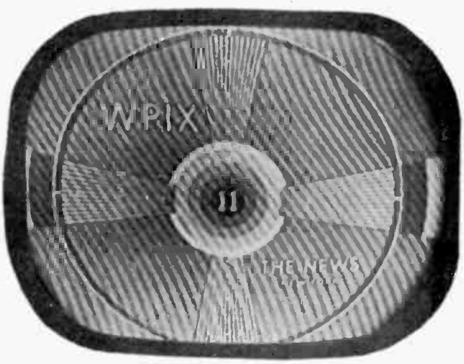
in armor, carrying a shield to protect him from arrows, swords and the like. Shielding in radio and TV is also a metal barrier; radio-frequency signals (wanted *or* unwanted) find it difficult to penetrate a metal shield. That's why a TV set inside of a metal building, with no outdoor antenna, would be able to receive practically nothing.

Shielding may be effective in eliminating or reducing interference *which originates in the vicinity of the set.* For instance, auto ignition interference might be picked up by the transmission line as well as by the antenna. Shielded transmission line ("coax") from the antenna to the set would pretty effectually close the door to such pickup. Sometimes shielding is needed right at the TV set. An example of this was an actual situation we have seen where it was determined that interference was coming from a building right across the street. It was licked by tacking Reynolds Wrap aluminum foil onto the wall behind the TV set—the wall, that is, which faced the building from which the interference was coming.

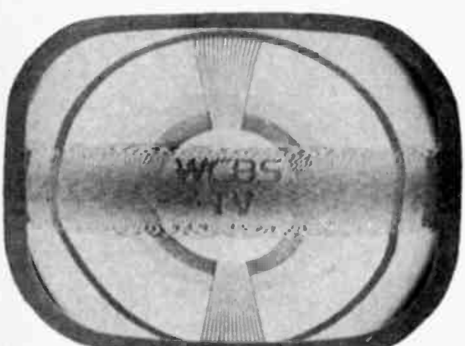
With the antenna positioned as well as possible, the lead-in shielded, the set shielded and a trap on the set to eliminate interference picked up by the antenna, we've covered about every angle possible. In weak-signal areas, after these methods have been employed, you may have to resign yourself to whatever is left of the interference. In strong-signal areas, interference can usually be completely eliminated, because it is not strong with relation to the signal.

There is one other path of entry for certain types of interference, and that is the electric power line which brings current into your set. This might be the source of interference from motors, refrigerators, elevators and fluorescent lamps. Traps (usually called "line noise filters") are available for this type of interference, too. But since you can't be sure that this is the source of your trouble, it is wise in this case, too, to try to buy one on the condition that you can return it if it doesn't do any good.

There is one other source of radio-frequency interference and that is nearby TV sets. This is not common, but occasionally occurs when another TV set is close by (as for instance, in the next apartment), when two TV antennas are right next to each other (as on an apartment-house roof) or when several sets are connected to a "master antenna" system. For the



1) Radio Frequency



2) Diathermy

3) Ignition Interference

Fig. 57—Interference patterns.

first instance, shielding of the set might help; for the second, repositioning of the antenna, if possible. In the third case, the "master" system is not doing its job well. The only possible solution would be a petition from all the tenants requesting an improved distribution system which does not radiate interference from one set in the building to another.

The appearance of typical cases of interference is shown in the accompanying illustrations. Eliminating troublesome interference is often a process of trial and error and every clue to a more precise identification of the source will help in selecting the proper method of reducing the effects of it.

CHAPTER 6

What Can Go Wrong With Your TV Set

IF you have read the chapters on antennas and on interference, you have already found out about some of the causes of unsatisfactory pictures on your TV set, and how to correct these troubles. These are important facts to learn because one of the most important steps in TV repair is the initial diagnosis: exactly what are the symptoms, and what sort of defect is usually the cause of such symptoms?

Uncontrollable vertical rolling, for instance, is usually a symptom of something wrong in the vertical sync circuits of the set; but if it is accompanied by snow and a weak (dim) picture, it is more likely the result of a very weak signal being delivered to the set. If the picture was OK yesterday, but is weak, snowy and unstable today, we would expect that something has happened to the antenna. But if the antenna and the transmission line are in perfect shape, then we would look for trouble in the front end (the tuner) of the set. Why? Because it is the first stage which the signal goes through after it enters the set from the antenna.

The previous paragraph is typical of the sort of mental process which one goes through in trying to pin down the trouble. Up to this point in the book, we haven't said anything about the inside of the set, except (in chapter 2) to explain about tubes, the troubles they can develop, and how to remove and replace them.

A little detective work

To understand the "chassis," and work out a mental process of elimination for finding trouble in it, we must refer to the accompanying illustration, which is called a functional block diagram. To explain how such a diagram can be helpful, let us suppose this example:

Three people eat lunch and immediately afterward, one of them has food poisoning. We want to find out what caused it. We find that each of the three had a sandwich and a cup of coffee. No clue there, since only one got sick. Each had cream and sugar in his coffee. Each had rye bread and butter on his sandwich. But the man who got sick had roast beef, while the other two had ham. So we find that the

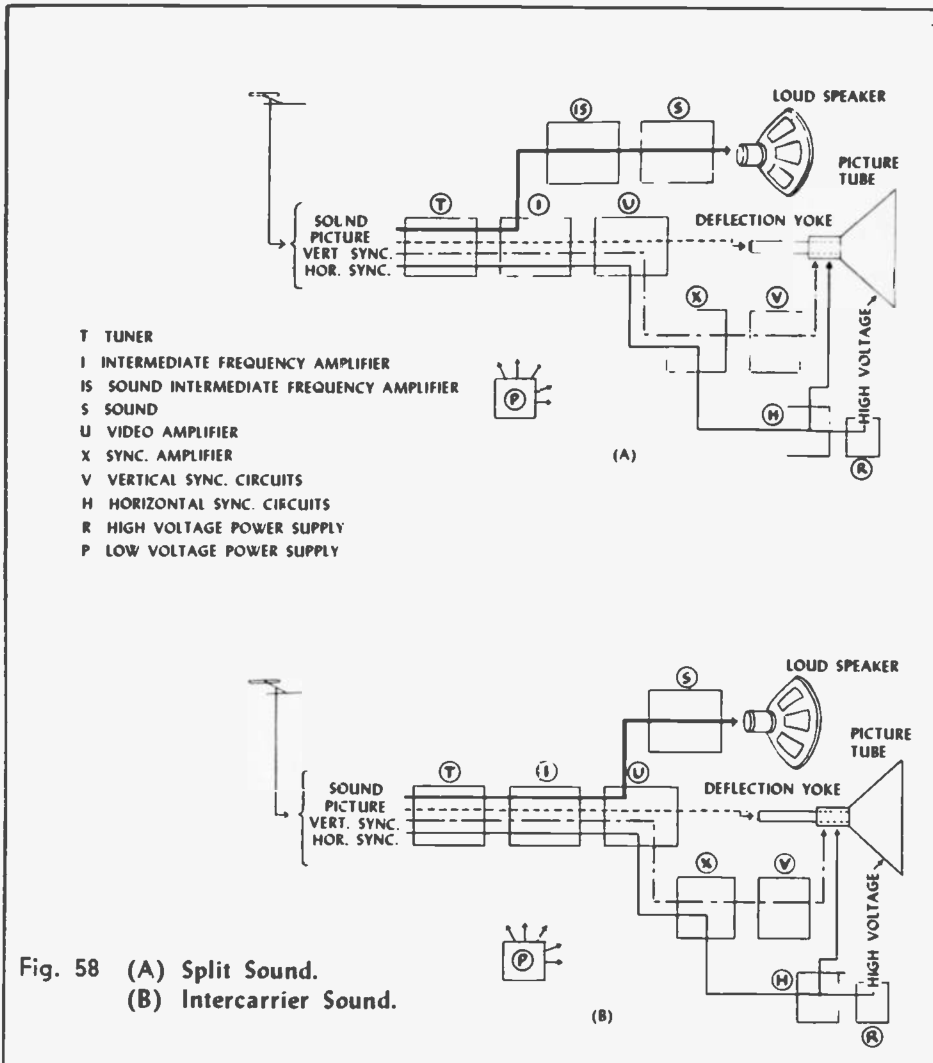


Fig. 58 **(A) Split Sound.**
(B) Intercarrier Sound.

roast beef was the only item which the sick man had and the other two did not have. We therefore suspect the roast beef and we have it analyzed.

We can use this same sort of reasoning on the TV block diagram, trying—if possible—to *isolate* the trouble. To isolate it, we first consider all the elements which can get into it, just as we considered the coffee, sugar, cream, bread, butter and the filling for the sandwich. In the TV set, we start off with two basic elements: (1) the composite signal, broadcast from the TV station and reived by your TV antenna, and consisting of picture, sound, horizontal synchronizing elements and vertical synchronizing elements; (2) Elements within the set, consisting of the electric power to operate it—and this is converted by the "power supply" to AC (alternating current) and DC (direct current) voltages of from 6-300; the tubes, which must light up and operate whether a signal is received or not; and the picture tube circuits which cause brightness on the screen whether a signal is received or not.

When is a picture not a picture?

The word "picture" is considered to describe any picture information, whether or not it is a "good" picture. Thus, if we have a classic case of "no horizontal sync," where the picture is all broken up into diagonal segments, we do have "picture." That is, we know a picture signal is being received. The trouble is that it is not in sync. There are only two times when we would say we had "no picture," and those are: (1) when the screen is totally dark, and (2) when the screen is totally white—that is, it has brightness, but not a trace of a signal, however unintelligible.

But it isn't even correctly descriptive to call #1 "no picture," since—with no brightness on the screen—we cant really tell whether there is "picture' coming in or not. So we describe this as "no brightness," or "no raster." The word "raster" is the technical term used to describe the pattern of bright lines which appear on the screen when there is no picture. These are the lines on which the picture will be "painted," and their existence is proof that certain parts of the set are OK.

For instance, with a raster, we know that: the power supply is supplying power, that the horizontal and vertical deflection circuits are working, that the picture tube is working, and that the high voltage power supply is working. "High voltage" for the picture tube means 10-20,000 volts.

If we had a raster and sound, we would know that a signal was being received (the sound proves that) and that the sound is OK, in addition to all the other factors just listed in the previous paragraph. So we might suspect the "video" section.

You have probably heard that "audio" and "video" are the latin words meaning "I hear" and "I see," respectively. It is from the root of those words that we get the English words "audible" and "visible."

Working back from the end

If you remember that we started off from the antenna with a "composite signal" which contained four elements, you'll see that the video section is the end of the line for the picture part of that composite signal, while the audio section is the end of the line for the sound part of it. The next, and last, stop for these two elements are the picture tube and the loudspeaker respectively.

The way we operate our "mental process of elimination," then, is to start at the end—at the picture tube and the loudspeaker—and try to see what elements are present and which are missing, being as specific and accurate as we can in our diagnosis. We might come up with such diagnoses as these:

1. No raster, no sound
2. Sound OK, but no raster
3. Sound and raster OK, but no picture
4. Sound, raster and picture present, but no horizontal sync
5. Sound, raster and picture present, but no vertical sync
6. Both horizontal and vertical sync missing
7. Picture OK, but no sound
8. Sound OK, picture present and in sync, but weak
9. Sound weak, picture OK
10. Picture and sound present, but picture consists only of a narrow band across the middle of the screen.

Of course, that's not an exhaustive list (we wouldn't want the reader to be exhausted!) but it should give you a pretty good idea of how the "diagnosis" process operates. Notice, there isn't anything in the list about such things as snow, ghosts and interference, which are most likely reception troubles. And there's nothing in the list about the picture being out of shape or out of focus, which are most likely due to improper adjustment of the controls.

So you see, your *complete* diagnosis process would enable you to decide that some problems are solved by making adjustments; some are solved by looking for trouble in the antenna system; and some are solved by looking for trouble within the set.

Solving a typical problem

Now let's suppose that your trouble were No. 1 above: no raster and no sound. Is the set turned on and plugged in? Do you know for sure that the electric outlet in the wall is OK (maybe there's a lamp plugged into it, too — does it work?). If so, we can presume that there is "juice" coming into the set. Are the tubes inside lit up? Assuming that the answer is, "yes," then is there any hum in the loudspeaker? Turn the volume all the way up and listen. If there is, we know the set is working, even though it isn't doing anybody any good at the moment.

Since the trouble is common to the whole set, we would suspect something which affects the whole set. namely the "power supply." If you look inside the cabinet of your set. you will find a diagram pasted inside there which shows the name and location of all the tubes. You'll find one labelled "low voltage rectifier." Let's suppose that it's a 5U4. We have every reason to suspect that there is something wrong with that tube, so we remove it and pop in a new one. Ah! here comes the sound, and now here's the picture, and everything's OK—better turn down the sound, though. Remember? — a minute ago we turned it all the way up to see if there were any hum.

Let's try another one, No. 10: a narrow band of picture across the middle of the screen. Anything which pertains to the "up-and-down" nature of the picture comes under the heading of "vertical." Here we see a case of insufficient vertical size, the technical name for which is "vertical deflection." We look in our tube diagram and find a tube called "vertical output," which we will suppose in this instance to be a 6S4. Pop in a new one and, boom, there's the picture.

That's the method, but we won't expect the reader to learn *what to do* after he has diagnosed the trouble. We have provided in the next chapter a picture of each kind of trouble, together with suggestions for locating and eliminating it.

Using the block diagram

Now let's go back for another look at that functional block diagram on page 65. You will find listed there the various sections in a TV set, and on the diagrams, you will find letters corresponding to these sections. The principal thing to note from these diagrams is to see in which sections the 4 parts of the composite signal are all alone, where they are in pairs, and where they are all four together.

The difference between the two types shown (split sound and intercarrier sound) is the place at which the sound splits off from the composite signal. Most newer sets are the intercarrier type. At right is the tube "lineup" of a recent set, with a letter after each one, showing which of the blocks it would fit into in the diagram on page 65.

You can fit your set's tubes into blocks in the same way by watching for the key words, like "sound," "audio," "horizontal," "vertical," etc. "RF" means "radio frequency," and you'll always find it in the Tuner (T). "IF" means "intermediate frequency." "Output" usually signifies the last tube in a circuit, the one which supplies power. The audio output tube supplies sound power to the loudspeaker; the video output tube furnishes picture power to the picture tube; the horizontal and vertical output tubes supply deflection power to the picture tube via the "deflection yoke," a brace of coils around the neck of the picture tube.

If there is no vertical output, you will see a narrow band or line of light *across* the face of the picture tube. But if there is no horizontal output, the screen will be dark, since the operation of the high voltage system depends on the operation of the horizontal output.

In the set listed here, the RCA 21-S-503N, a crystal diode (see picture and description of crystal diodes in Chapter 2) is used in place of a tube. More often, the function of "picture detector" might be performed by a tube, such as the 6AL5. But, as we explained in the chapter on tubes, diodes are used when possible, to save space and heat. They are

	RCA Model 21-S-503N		
1.	6BQ7A	RF Amplifier	(T)
2.	6X8	RF oscillator, mixer	(T)
3.	6CF	1st pix I.F. amplifier	(I)
4.	6CB6	2nd pix I.F. amplifier	(I)
5.	6CB6	3rd pix I.F. amplifier	(I)
6.	CR-101 (crystal diode)	Picture second detector	(I)
7A.	6X8	1st video amplifier	(U)
8.	12AU7	AGC amplifier and Video Output	(U)
9.	6AU6	Sound I.F. amplifier	(S)
10.	6AL5	(sound) Ratio Detector	(S)
11.	6AV6	1st audio amplifier	(S)
12.	6AS5	Audio Output	(S)
7B.	(½ of 6X8 listed as 7A)	1st sync amplifier	(X)
13A.	12AU7	sync output	(X)
13B.	(½ of 12AU7 listed as 13A)	Vertical oscillator	(V)
14.	6AQ5	Vertical output	(V)
15.	6SN7-GT	Horizontal oscillator	(H)
16.	6BQ6-GTB	Horizontal output	(H)
17.	1B3-GT	High voltage rectifier	(R)
18.	6AX4-GT	(high voltage) damper	(R)
19.	5U4-G	Low voltage rectifier	(P)
20.	21AMP4A	Picture tube	(P)

much less likely to fail and cause trouble than tubes are, and so usually you will not look for trouble in this quarter. You cannot see that a crystal diode is "working" by looking at it.

Fuses used for protection

Many sets have fuses to protect certain circuits. These are small, tubular affairs, but perform the same function as the larger, screw-based fuses you have in your house electrical system. Inside the glass fuse is a small link of wire which becomes part of the electrical circuit in which the fuse is inserted. This wire has a precisely determined limit on the amount of electrical current it will carry. When that limit is exceeded, the wire melts, leaving a gap in the electrical circuit. Technicians would call this an "open," or an "open circuit." Electrical and electronic circuits stop working when there is an open.

So the fuse performs this function: when the normal amount of current expected in the circuit is exceeded, the fuse melts, the circuit opens and the current stops flowing. When the situation is corrected which caused the fuse to blow, the circuit will still not operate until a new fuse is inserted.

You can see whether a fuse is

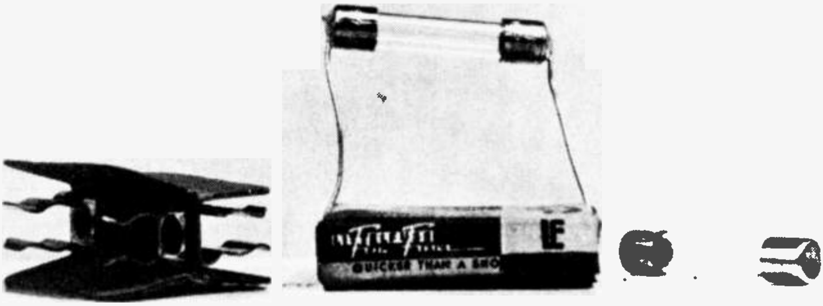


Fig. 59—In the center is a pig-tail fuse, which needs to be soldered in place. At right is a cartridge fuse. At left is an adapter which can be used to convert from pig-tail to cartridge type fuse, to avoid soldering in a replacement. One side of the adapter snaps onto the existing pig-tail fuse in the set, and a new cartridge fuse is snapped into the other side.

"burned out" by looking at it—it seems to be just an empty glass cylinder. It might make it easier for you, though, if you would buy a fuse and get a close look at a good one. Invest a dime in a ¼-amp Type 3AG cartridge fuse and get acquainted with it if you are not already.

You know that your house fuses may have 15 to 30 ampere ratings; most TV set fuses are rated between ¼ and 1 ampere, depending on the circuit in which they are used. They may be "quick-acting" or "slow blow." The slow-blow type are used in circuits where temporary overloads are common and the fuse does not react to them; but if the overload is prolonged, the fuse will blow. Fuses may also be "standard," to clip into a fuse-holder, or "pig-tail." The pig-tail fuses have a little wire on each end and are soldered into the circuit in which they are used.

The fuse link inside the glass may be a fine piece of wire or a small metal strip. Slow-blow fuses have a coil spring inside. On the outside of the fuse you will see lettering which indicates the type and size of the case, such as 3AG or 4AG, and the amperage, such as 1, ¼, .3, etc. Needless to say, a fuse should always be replaced with an exact duplicate.

Interlocks and cheaters

The Underwriters Laboratories (U-L) require manufacturers to provide certain protections in a TV set such that the untrained consumer cannot be harmed by the presence of high voltages (up to 20,000 volts). One of these protections is an "interlock" built into the back cover of the set. Most sets are constructed in this way: the line cord (the electrical cord you plug into the wall) is riveted to the back cover of the set. On the inside of the back cover is a plug which fits into the chassis. When the back cover is removed, this plug comes out of the chassis, and the line cord no longer brings current into the set.

Because technicians must work on the set when it is operating, they carry an extra line cord which can be plugged into the chassis after the back cover is removed. Because this cord "cheats" the protective interlock, it is called a "cheater cord." Such cords are purchasable at radio parts stores and from radio parts mail order houses for between 25¢ and 50¢. In addition to the power-line interlock, some sets have one which disables the high voltage when the back cover is removed.

A word to the wise

Before you proceed to "cheat" the various protective devices on your set, here is some advice for keeping out of trouble. Replacing tubes in a TV set is a relatively simple job, as we explained in chapter 2—but it is a job for a "handy-man," not a "butter fingers." The safest way for the average untrained person to work on a TV set is when it is turned off. You will need to have it turned on to see if the tubes are working; but you can use the cheater cord for looking, then turn the set off to take out a tube and put in a new one.

If you are a handy-man, you will find it quicker and easier to leave the set on, but remember you can get a shock if you're not careful, or you can get a burn from touching a hot tube. So: have plenty of light, so you can see what you're doing; and have plenty of room so that you can work easily. A good rule which even experienced servicemen follow is to keep one hand in your pocket when reaching into the set. The reason for this is that we tend to work with the hand

Fig. 60—A tube layout diagram will be found pasted inside the cabinet of your TV set, as shown at right in the picture below. This is the cabinet of the RCA 8½-inch portable set.

that's easiest, and rest the other one without particular care as to where we rest it. So, to avoid touching something hot with the unused hand, keep it tucked out of harm's way.

The most important admonition is one which we made earlier in this book, in connection with the adjustment of controls, and that is: don't make any changes unless you have a pretty good idea of what you expect the result to be. For instance, don't pull a tube out unless you have found out (through a diagram or some other way) which tube it is and what it is for. Or in other words, don't replace tubes willy-nilly, hoping that one of them will be the right one.

Don't be too eager

Another precaution, which it is worthwhile to repeat, is not to remove more than one tube at a time without making positive identification of the tube itself and the socket from which it came. It can be very embarrassing to find yourself holding three or four tubes and not know which is which.

Don't fiddle with screw adjustments when you don't know what they are for. Most of the top-chassis screw adjustments are precisely made with the help of test equipment and cannot be restored to their right position merely by observing the effect on the picture.

Trouble is not always serious; sometimes it is very simple, and you should remember not to overlook the obvious. Keep your eyes open for simple little things such as: the line cord not plugged into the wall; a disconnected wire, such as the connection of the antenna to the set; or a tube bent over in its socket so that the pins do not make good connections in the socket. The connection to one of the capped tubes (see chapter 2) may be off, or the high voltage connector to the picture tube may be disconnected. One tube which is unlit when all others are lit is, of course, a pretty obvious signpost. But if you suspect such to be the case, turn off the lights and look at the tube again; some of the miniature tubes light up very faintly and can only be seen in the dark. The normal appearance of a lighted filament in a tube is something you have to become accustomed to, and varies from tube to tube. But generally, it is a reddish-yellow light. A very bright white light, or purple, is *usually* a sign of a bad tube.

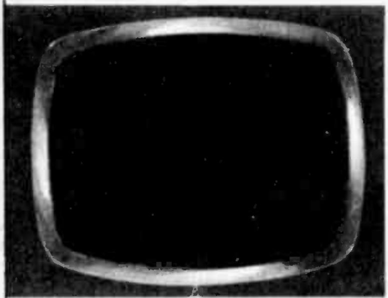
Usually, the hottest tube in the set is the power supply tube, or "low voltage rectifier." It may be such a type as a 5U4, 5Y3 or 35Z5 (usually the letter in the type number is one of the last letters in the alphabet). This is one tube you should be sure not to touch until you are sure it has cooled off a bit. Output tubes, such as the audio output, horizontal output and vertical output, also tend to run pretty hot. All these tubes handle *power*, and the dissipation of heat is a characteristic of power.

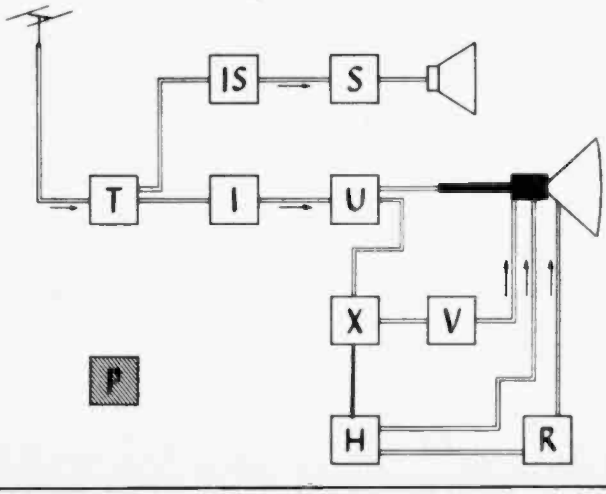
Sometimes, as explained in the chapter on tubes, a "selenium rectifier," or a pair of them, is used for the low voltage power supply instead of a tube such as the 5U4. Selenium rectifiers dissipate practically no heat, and are apt to last much longer than tubes.

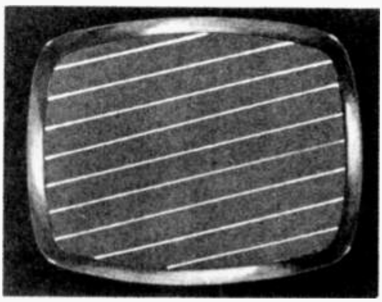
The pictorial trouble-shooting section which follows as the next chapter will simplify your process of diagnosing, isolating and correcting the trouble you have in your TV set. This easy-to-follow guide will get your set on the ball again in up to 2/3 of all the breakdowns you might have. When your attempts to remove trouble by adjustment or tube replacement do not do the trick, it's time to call in a serviceman. There will obviously be times when parts under the chassis, which are soldered in place, need replacement; and/or when test equipment is needed to diagnose the difficulty. Servicemen have the know-how and the equipment to do these jobs when they are needed. This book is designed to save you money by making it unnecessary to call a serviceman *most* of the time; don't feel badly if, occasionally, it is necessary to seek professional help.

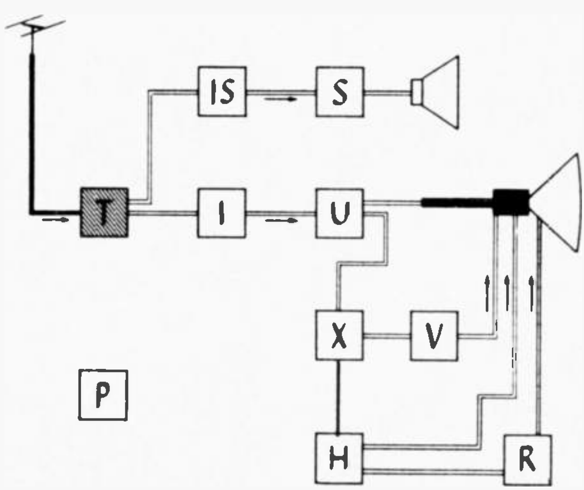
CHAPTER 7

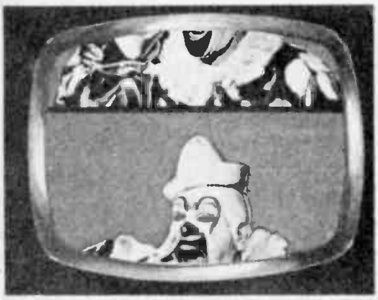
TV Trouble Clinic

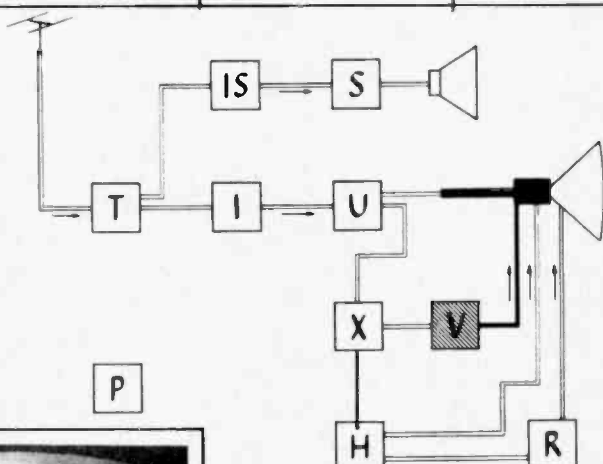
HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	1 Dead set: No sound, no picture, no hum, no tubes lit.	Defective wall plug; defective line cord or plug on TV set; interlock loose or intermittent; blown fuse in set.
	2 Tubes lit but no raster, no picture, no sound.	Check "P" tube. Also check for blown fuse on set.
	3 Sound OK but no raster.	Check "R" tubes, "H" tubes, picture tube, high voltage connector, fuse in high voltage compartment.

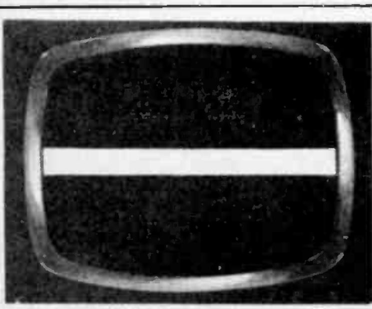


HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**4** Raster and picture but no sound.	Check "IS" and "S" tubes; check speaker.
	**5** Raster and sound but no picture. **6** Raster, but no sound or picture.	1. Check antenna, especially in weak signal area. 2. Check T, I and U Tubes.

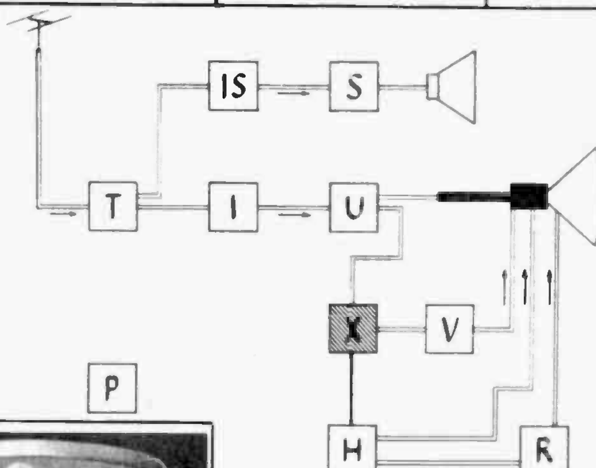


HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**7** Sound OK, picture present, but won't stop rolling vertically (no vertical sync).	Check setting of vertical hold control. Check "V" tubes.
	**8** Picture not high enough to fill screen to top and bottom of mask, or frame.	Adjust height and vertical linearity controls. If this does not help, check "V" tubes, especially 6AQ5, 6BL7, 6K6, 6S4, 25L6. If both insufficient width and height, check "P" tube.

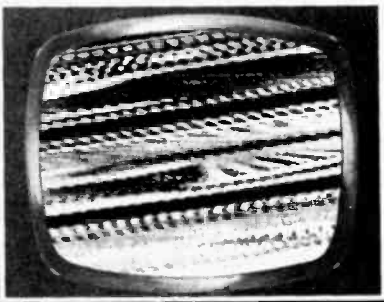
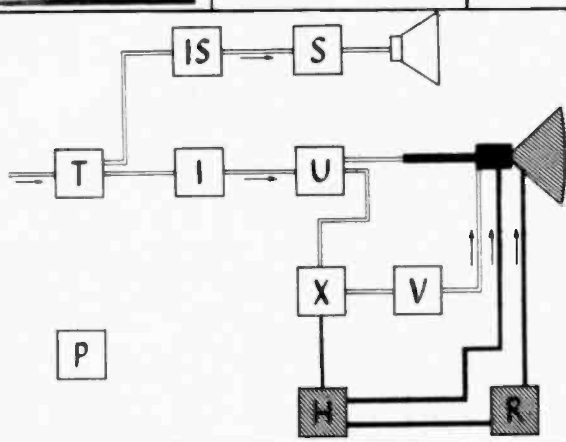


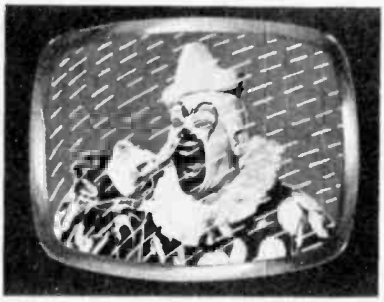
	**9** Sound OK, but nothing on screen but thin line across	Trouble is no vertical deflection. Check "V" tubes, especially 6AQ5, 6BL7, 6K6, 25L6.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**10** Picture unstable vertically—has the "jitters."	1. Contrast or picture control advanced too far. 2. Check setting of vertical hold control. 3. Check "V" tubes.
	**11** Sound OK and picture present, but no horiz. or vert. sync.	Check setting of hold control. Check "X" tubes, then "U" and "I" tubes.



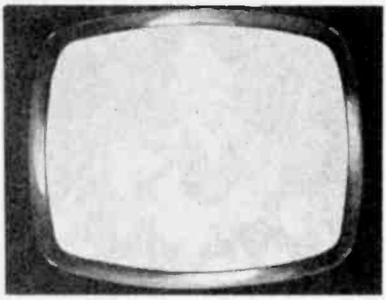
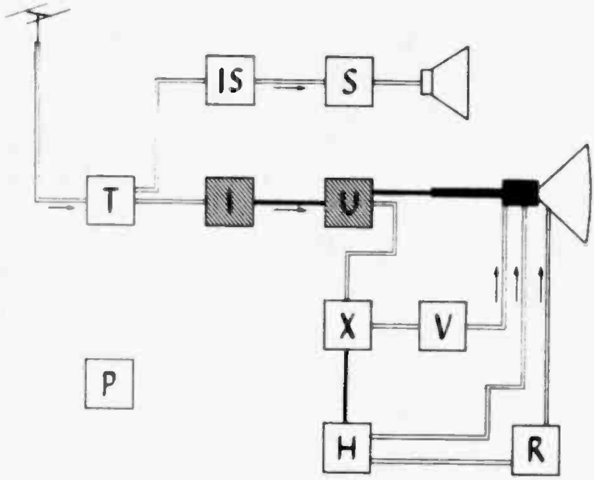
	**12** Picture blurred all over, and on every channel.	Adjust focus control. If can't get focus all over screen, adjust position of focus magnet.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**13** Sound and picture present, but low brightness.	Check "R" tubes, "H" tubes and picture tube.
	**14** Sound OK, picture present, but no horizontal sync.	Check setting of horizontal hold control. Check "H" tubes.
		
	**15** Picture not wide enough to fill screen; at all times and on all stations.	Adjust width, horizontal linearity and horizontal drive controls. If this doesn't help, check "H" tubes, particularly 6BG6, 6CD6, 6BQ6, 6AU5. If both insufficient width and height, check "P" tube.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**16** Picture out of proportion vertically; Faces look long and thin and circles look oval.	Adjust height and Vertical Linearity controls to obtain round circle.
	**17** Picture out of proportion horizontally. Faces and circles flattened on top and bottom.	Adjust width, horizontal linearity and horizontal drive to obtain round circle.
	**18** Flashes in picture, sometimes accompanied by noise in sound.	Loose connection at antenna or lightning arrester, or break in line.
	**19** Pictures varies in size from time to time; especially, gets smaller when refrigerator or oil burner goes on.	Due to fluctuation of house line voltage. Install voltage regulator or ballast.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**20** Venetian blind efect, like shades slowly moving up or down on screen.	Interference between two stations in different cities on the same channel. Found in fringe area between two distant stations in opposite directions. Install antenna with high front-to-back ratio. See chapter on antennas.
	21 Dark bars across picture (several) on some stations at some times.	SPLIT-SOUND SETS Station not properly tuned in. Adjust, fine tuning control.
	**22** Sound and picture not in step—sound no good when picture is best.	Noticed on split-sound sets in fringe or weak signal areas. Nothing wrong. Should tune for best sound. Try better antenna, orientation, or booster to set stronger signal.
	**23** Ghosts, or double image.	Try orientation of antenna. See chapter on antennas.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**24** Snow—little dots all over picture. Means very weak picture signal. Common in fringe areas.	Try better antenna, orientation, or booster. See chapter on antennas.
	**25** Shadow in corner of screen—on all stations, at all times, and even on raster when no picture on.	Corect positioning of focus coil or magnet and ion trap.
	**26** Weak sound and picture, combined with undersized raster, both horizontally and vertically.	Weak "P" tube, or tubes.
	**27** Little dashes through picture.	Ignition interference from passing autos. Noticeable in weak signal areas. Put antenna higher—move antenna away from street.

HOW IT LOOKS	WHAT IT IS	WHAT TO DO
	**28** Picture weak, gray, lacking in contrast. Sound OK.	1.Check setting of contrast control, and AGC switch, if any. SPLIT-SOUND SETS Check I and U tubes, especially 6AQ5, 6V6. INTERCARRIER SETS Check U tubes.
		
	**29** especially 6AQ5, 6V6. Pattern over screen, either diagonal or straight up and down.	Interference. Orient antenna, shield lead-in, install trap. See chapter on interference.

CHAPTER 8

What You Should Know About Color TV

1956 may later be considered the year in which color-TV came of age. This does not mean, however, that by the end of 1956 it will have superseded black-and-white television—not by any means. As a matter of fact, it may never supersede black and white. It is significant to note that, after over 15 years, less than half of all motion pictures made are in Technicolor (or any other kind of color).

But what *is* happening is that there are now good, large-screen sets being made for color, many dealers are actively promoting them, and a number of TV programs are being broadcast in color. In other words, after a number of false starts and false alarms, color seems to be getting under way.

The "green light" for the current system of color-TV was given by the Federal Communications Commission (FCC) on January 22, 1954. If we consider 1954 as "the year 1" for color, we can compare it with 1946 for black-and-white TV. In year no. 3 (1948) the industry produced and sold 1 million sets, and in year no. 4 (1949) 3 million sets.

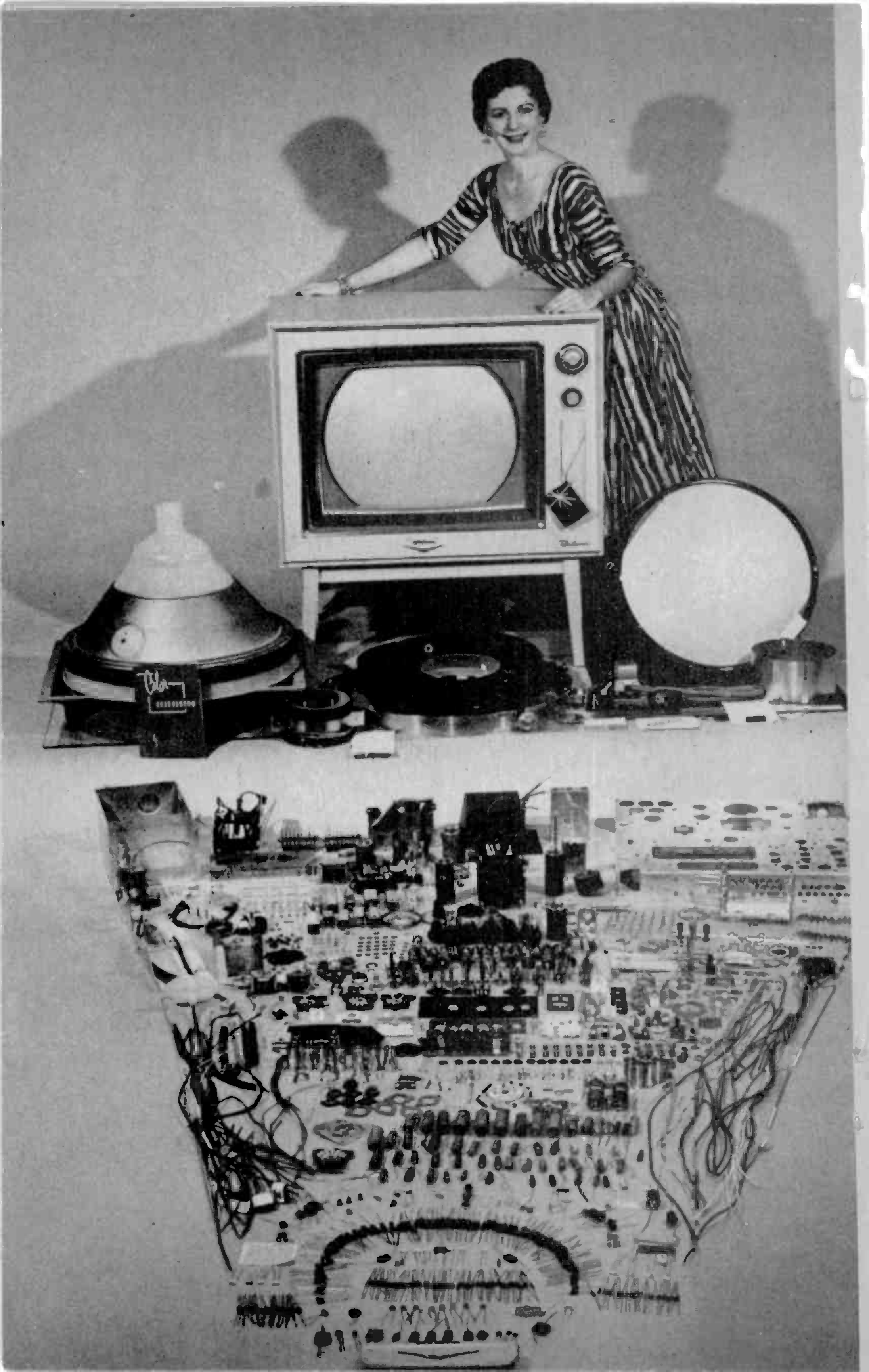
But in year no. 3 for color-TV (1956), industry estimates run between 150,000 and 250,000 sets. And these sets will be more than twice as expensive as sets were in 1948.

To sum up the statistics, six-tenths of one percent of all the sets in use at the end of 1956 will be color sets. You could hardly refer to this as "saturation." At the end of 1957, this may be up to 3% and by 1958, may be 10%. These facts on saturation will give you some idea of what to expect in programming in the near future, since the expenditures of the networks and the sponsors are naturally related to the size of the audience.

Adaptability, Convertibility, Compatibility

But as color-TV grows on us, you will find yourself hearing new terms and descriptions, and you might as well start now getting familiar with the facts.

The first, and simplest, term is "*monochrome*." This means "one color," and is the correct term for present (black and white) TV. As was mentioned in chapter 1, present TV doesn't "create" black; it



simply consists of light and absence of light. Technically speaking, it's not a color at all, but for the sake of simplicity in comparing what we have now with color-TV, we call black and white "monochrome."

"*Compatible*" is another word you'll hear a lot of. The system of color broadcasting now used is compatible, which means that it can be received on either monochrome or color sets. Of course, monochrome set owners will not see the program in color, but they *will* be able to see it, and at least as well as they see any other program. This is an important point; with broadcasting practices (for color) in use prior to 1954, monochrome sets would not have been able to receive color programs at all. Since all color broadcasting now and in the future will be by means of a compatible system, you need never worry that your set will be "blacked out" because of the growth in color-TV.

Can your set be *adapted* to receive programs in color? The answer is simple: no. Can it be *converted* to color? It's possible, but not practical. The cost of a special picture tube for color, plus the new tubes and circuits needed, plus the labor, would make the cost of conversion so costly as to be inadvisable. You might just as well buy a color set; and the results would be better if you did.

There is one type of converter available today which, for somewhere between $150 and $200, will permit you to see color programs in color, although not in quite the way a color set would. On a color set, you look directly at a large screen picture tube on which the colors are produced by the excitation of colored phosphors on the inside of the tube.

In the COL-R-TEL converter, manufactured by Color Converter, Inc., of Columbia City, Indiana, your present monochrome set continues to produce a black and white picture, but a "color wheel" revolves in front of it so that you see the picture in color.

The color wheel is about 30 inches in diameter, and consists of pie-shaped plastic segments in the three primary colors, red, blue and green. The wheel is enclosed in a case with an opening on one side for the picture. An electric motor causes the wheel to revolve. Approximately 10 connections from your set to the 7-tube color chassis which accompanies the wheel provide the electronic information necessary to keep the wheel in synchronization with the picture as broadcast from the TV station.

Fig. 92—(left) More than 2,000 separate parts go into an RCA 1956 color-TV set. More parts and more labor make color sets more costly than black and white.

These connections require the services of a technician.

Regardless of the size of your TV screen, the COL-R-TEL unit produces the equivalent of a 14-inch TV set. As we said, the wheel is 30 inches in diameter, and to produce a larger picture than 14-inch would require an excessively large wheel.

After the connections have been provided, the unit is placed over the TV set and plugged in whenever a color program is available for viewing. For regular monochrome programs, the converter is unplugged and removed.

Although a little cumbersome, this unit does provide color-TV at a much lower cost than any color sets now available, which range from $700-$900 plus a service contract.

Is color TV true color?

Color-TV may eventually be perfectly satisfactory, but at the present its perfection is debatable. It is necessary, at the studio and again at the set in the home, to adjust electronic circuits to make the colors suit the beholder. In other words, it depends to a certain extent on the judgment of several people. And color is one thing that people agree to disagree on. The human complexion, for instance, is a tough thing to reproduce naturally, and to the satisfaction of everyone viewing the result.

The writer has yet to see a color demonstration of several sets in which any two of the sets were producing identical color hues at the same time. These problems will be worked out in time, as all other technical problems have been and will be—but the time hasn't yet arrived. As prominent an authority as the executive vice-president of the General Electric Company said in December, 1955 that the industry still does not know how to make a good color television receiver. What the industry needs now is not more laboratory work, however, but more field experience. It needs to make and sell more sets and have the sets used. Volume in manufacturing can eliminate the bugs and bring down the cost.

What are the color sets like?

If you had a color set right now, could you fix it with the help of this book? Hardly! Although the principles of operation are the same, and also hte techniques of diagnosis, isolation and replacement, color sets are much more complicated. That is why most color sets today are sold with a compulsory service contract. For one thing, there are many more controls, parts and tubes than in a monochrome set, and failure of parts of tubes is occurring more frequently than in monochrome sets.

Referring back to chapter 1, you will recall our listing 17 controls usually found on monochrome sets, of which 6 are "operating controls" and 11 are "non-operative" adjustments. A typical color set has 42 controls, of which 13 are operating controls and 29 are non-operative adjustments. Or to put it another

Fig. 93—Hoffman 21-inch Color-Caster console has seven knobs for adjustment on the front of the set, more in the rear.

way, it has the same 17 controls the monochrome set has, plus 25 additional ones.

Why so many? Well, in the first place, we have some new functions to perform, such as "convergence," which has to do with the register of the three colors on top of each other. Then we have overall controls for color. Then, in addition to the ordinary "contrast" control —you'll recall that we explained that contrast is a measure of signal strength — you'll find a signal strength for each of the three primary colors. And in addition to "brightness" — which is a background control—you'll find a background control for each of the three colors.

Another language

Lest this all sound like so much doubletalk, we'd better explain some of the terms and facts about color reproduction. First, those three colors: as in full-color reproduction in magazines, color reproduction in TV is accomplished with the judicious mixture of three primary colors. But they're not the same three colors.

In mixing paint and printer's inks, where our eyes see the resultant opaque material by reflected light, the primary colors (from which all other colors can be obtained) are red, yellow and green. The sum total of these colors is black. But when we mix colored light, the primary colors are red, blue and green and the sum total of all colors is white. You know this to be true because of daylight (sunlight) which appears to be white light and yet can be shown, by means of a prism, to be made up of all colors of the rainbow.

Brightness, *hue* and *saturation* are three terms which are important to an understanding of color. Brightness is a measure of the light output, and is independent of color. Hue is the word for which the ordinary layman uses the word "color." That is, the hue is either red, blue, green or a mixture of two or more. Saturation (also called "chroma") is the measure of the dilution of the hue with white.

As examples, leaf green might be described as of medium brightness (or brilliance), green hue and medium saturation, whereas pink might be called high brightness, red hue and low saturation.

You can imagine that if the overall picture had a washed out

Fig. 94—The RCA 21-inch color picture tube, called a "shadow mask type" color tube, has three electron guns and is of glass-metal construction. The 22-inch, rectangular, all-glass color picture tube will eventually replace it.

appearance, you might turn up the "hue" control to strengthen all the colors. But if only the green were weak, you would turn up the green control only, in order to get it into what seemed its proper relationship with the other colors. If one of the colors were turned up too much, everything might be a tinge or cast of that color.

Since we don't really know what color the objects on the screen should be, we have to rely on something fairly familiar, like the human face. This is why "skin tones" are usually carefully observed by critics of color-TV.

Convergence is a term related to a particular type of color picture-tube, the "shadow-mask" tube. Instead of one, this tube has three same, and also the techniques of electron guns, one for each color. The beams from these three guns must converge on a single spot on the screen, hence the convergence controls. When the beams do not exactly converge, we might see a "fringe" of red, for instance, around a person or an object. In printing, we would say the colors were "out of register."

We mention these details about color sets in order to give the reader some idea of what the sets are like and what he may or may not be missing. We have made no attempt to give a complete analysis of how color broadcasts are achieved or how color receivers work, as it would be of no more than passing interest at this time. Nor do we attempt to make any critical appraisal of color-TV. The reader will make this appraisal himself when he sees it. He and millions of others like him will call the turn on color by their approval or disapproval.

CHAPTER 9

Better Sound For Your TV Set

WHEN television first started to get going in 1947, the average price of a set was $375 and it had a 10-inch picture. Today the average price is slightly under $200 for a 21-inch picture. The remarkable technological achievements of the industry in making available a picture 4 times as large in area while only a shade over half the price have made it possible for over 35 million families to enjoy TV in their homes.

But in order to perform these marvels, it was necessary to concentrate on the picture and eliminate or minimize as much else as possible. One of the corners most frequently cut is the sound, or audio. The number of tubes and circuits devoted to sound is held to a minimum, the loudspeaker is as small as possible (usually either 4-inch or 5-inch) and the choice of a position for the loudspeaker is dictated by considerations such as the size and dimensions of the cabinet and the position of the chassis and picture tube inside of it, rather than by considerations of sound quality.

The result is that the small loudspeaker is usually on the side of the cabinet of a table model, instead of in the front. You know how much more difficult it is to hear and understand someone talking when they are looking in some other direction, and the same is true of a loudspeaker. To compensate for this, you must turn up the volume higher than you would if the speaker were facing you, and even then the quality of the sound is never quite the same.

There are four possible ways to lick the problem of loudspeaker placement: (1) Pay a little more and get a set with the loudspeaker in the front; (2) Buy a new loudspeaker in a cabinet which can be used as a base for your table model TV set, or buy the loudspeaker only and build the base yourself; (3) Disattach the present loudspeaker from inside the cabinet and provide a new mounting for it so that it faces front, or (4) Provide a "reflector" beside the present loudspeaker which would tend to throw the sound toward the front. These four are listed more or less in the order of preference.

A fifth solution, for a person who has Hi-Fi equipment and who is "handy" at assembling such things. This is to "take off" the sound from the TV set (at the discriminator or ratio detector output) and feed it into his Hi-Fi set. Then he will not only have a good loudspeaker, but a good audio amplifier as well.

The reflector idea is the simplest and cheapest, and possibly the least effective, but it does help. It works on this principle: loudspeakers tend to throw the sound out straight ahead, especially in the higher frequencies which determine the brilliance of music and the intelligibility of voices. Sound is, to some extent, reflected and absorbed by surfaces with which it comes in contact, the way light is. That is, sound coming in contact with something soft and irregular in texture — such as a carpet or drapery—will be absorbed. When it hits something hard and smooth —such as a mirror or a sheet of metal—it tends to bounce off or be reflected, like a carom shot in billiards.

If you place a reflector alongside of the loudspeaker in your TV set, you can "angle" the sound out toward the front. If you stand in front while someone else moves the reflector, you will immediately notice the difference. If the cabinet is not metal, you might fasten such a reflector to it. A handier solution is to obtain a cheap stand such as photographers use to hold a flood lamp. This can be adjusted to the right height and easily positioned near the loudspeaker.

Repositioning or replacing the loudspeaker is not difficult as far as electrical connections are concerned. You will find two wires leading to the speaker, and usually they are easily removable with clips. It doesn't make any difference if they are reversed. If you want to attach a different speaker in a cabinet outside of the TV set, all you have to do is connect the two wires to your new speaker. If you need a longer wire, any ordinary wire such as lamp cord will do for an "extension." If you want to take the speaker out of the TV cabinet and mount it somewhere else, you simply add extension cord to the two wires in the set and then connect them to the loudspeaker at the new position. But you'll need some sort of box (called "baffle") to house the loudspeaker after you take it out of the TV cabinet.

Fig. 95—If you get a better speaker for your TV set, you'll need a "box" to house it in. The Jensen "Duette," shown here, provides a cabinet for its speaker and at the same time, a stand for the table model TV set.

Many sets are equipped with a "phonograph jack" on the rear of the chassis. A "jack" is a hole (of a special type, of course) into which a phonograph is plugged. Usually there is a switch associated with it which allows you to shut off most of the tubes in the TV set while using its audio amplifier and loudspeaker for the phonograph.

TV plus phonograph

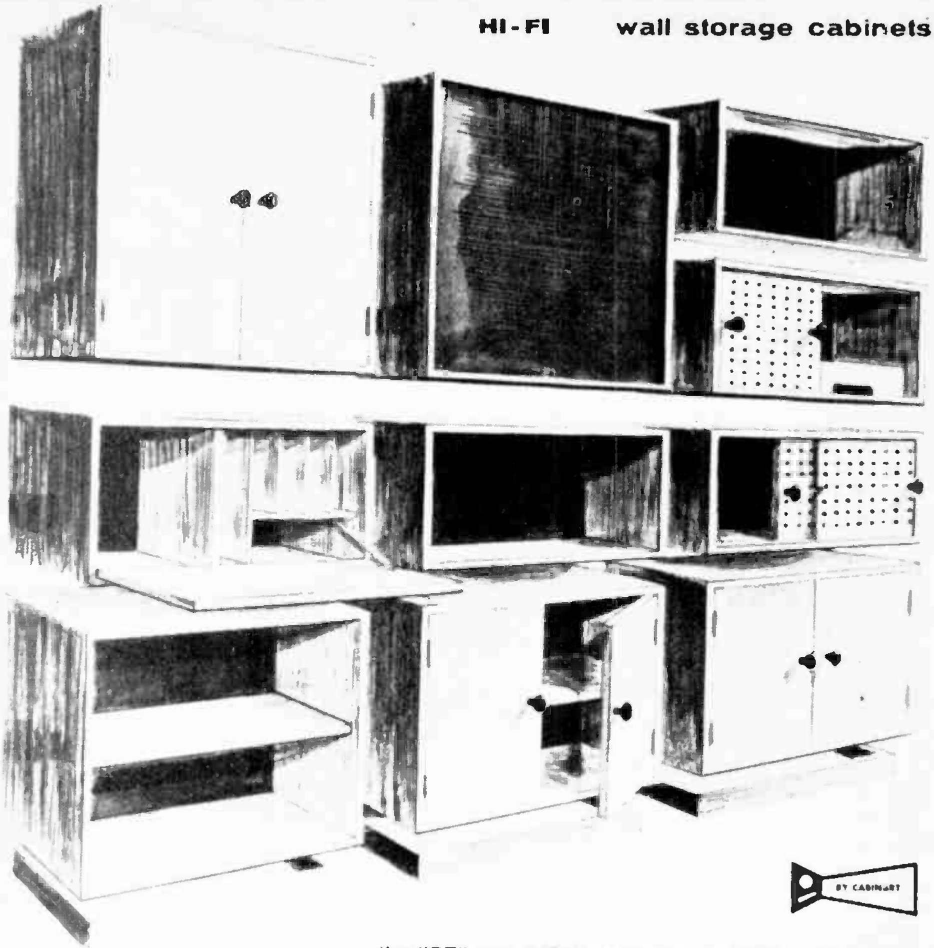
The type of phonograph which is intended is a phonograph "attachment" or record changer "attachment." The attachment is the mechanism for playing records only, without the amplifier and loudspeaker necessary to reproduce the sound. If your record player already has its own amplifier and speaker, you wouldn't and couldn't plug it into your TV set, nor would there be any advantage in doing so. If, however, you have a TV set equipped with a phono jack, you could have an amplified phonograph or record changer by merely buying an "attachment" and plugging it into the TV set. If you should decide to buy an attachment for playing records, be sure to tell the dealer what you plan to do with it, so that he can see to it that you get the right type and that there is a plug on the phonograph to insert in the jack on the TV set. In addition to the audio connection which plugs into the TV, there will also be an electric cord to provide power for the phonograph motor, and this plugs into the wall.

If you wish to have your TV set turned on at a specific time automatically (you might be afraid you'll forget to turn it on and so miss a program you wish to see) you may obtain a clock-timer such as is made by Telechron and General Electric. These clocks are made so that you can plug your TV set or any appliance (up to 1500 watts) into the clock, set the clock for when you want the appliance to turn on, and forget it. This sort of device is built into a clock radio and some television sets, but can be obtained separately and made to serve the same purpose.

Custom installation

For the "home handyman" who can build shelves, cabinets and the like, it is possible to put the chassis of your TV set into a custom cabinet or a "built-in" installation. The chassis, picture tube and loudspeaker are removed from the cabinet just as they would be for servicing. The way they are mounted in the original cabinet can serve as a guide for installing them in a new place. The mask, frame and safety glass for the picture tube will be needed, of course. If this assembly is molded into the table model cabinet, it will be necessary to obtain new ones for the custom installation. This type of equipment can be purchased at radio-TV parts stores or mail-order houses.

If you would like to install your set in a wall, you can forget it as a general rule. Usually there are only a few inches of depth to a



the "ST" and "KST" cabinets and hi-fi cabinet kits.

Fig. 96—If you are a "home handy-man," you may want to incorporate your TV into a custom set-up, along with radio, phonograph, records, books, etc. These cabinets made by Cabinart provide the materials for an attractive "storage wall."

wall, whereas the TV set is in the neighborhood of 18 to 20 inches deep. About the only time you can do this is when the set can be built into a closet, or when it is allowed to project through the wall into an adjacent room, or when a special false wall is made to accommodate it.

If you do anything to "custom install" your TV set, don't provide it with any less ventilation than it would have out in the room unless you provide fan-forced air circulation; and be sure to make it possible to get at the set when it requires servicing.

Adding casters

Casters will increase the "viewability" of either console or table model set (for the latter, the casters would have to go on the legs of the table). This permits the set to be turned for best viewing and returned to a less conspicuous position when not in use.

CHAPTER 10

How To Deal With TV Servicemen

WE pointed out in the beginning of this book that two-thirds of the service calls normally expected can either be avoided entirely or else can be handled by the set-owner himself if he is handy and if he learns a few essential facts and techniques—as he can by reading this book.

But what about the other third? These instances involve such things as the replacement of a resistor or a condenser; alignment; or the replacement of a major component such as a transformer, tuner, etc.

To intimate that such repairs could be performed after a cursory reading of a short book such as this one would be a gross misstatement. It would be short-selling the legitimate work of skilled servicemen.

We can best make this clear by using your automobile as an example. You can learn how to do many maintenance and repair jobs on your car, and save yourself time and money. For instance, you can change a tire; clean or replace spark plugs; replace a fuse or a light bulb; drain, flush and refill the radiator or the crankcase; adjust the spark setting, or the idling adjustment on the carburetor, etc.

But when it comes to grinding valves, putting in new rings, repairing or replacing the transmission or the rear end, or a new axle—jobs like this require the knowledge, experience, tools and equipment that your garageman has, including a specific knowledge of the design and operation of your particular make and model of car.

So it is with TV. TV servicing is a profession requiring extensive training, experience and an expensive array of complicated test equipment, and a supply of replacement parts, tubes, etc.

The investment in training, equipment and inventory is worth money to the serviceman and to his customers. We mention this because many people don't distinguish between "high priced" and "exorbitant." They feel that if the bill is high, they must be getting "gypped."

The actual cost to a dealer for service labor is from $3 to $5 an hour, and in some localities even more. This is exclusive of his overhead (rent, light, heat, telephone, taxes, stationery, postage, etc.), transportation (truck, taxes and insurance on it, maintenance, etc.), parts, test equipment, and so on.

If your set required service in the shop, it is easy to understand that the cost to the dealer of sending a man out in a truck to pick up the chassis, return it to the shop, and then return it again to the house and put it back in the cabinet could run to several dollars, exclusive of the cost of labor and parts used in the shop, to repair it.

Don't look for bargains

But the most valuable thing you buy from the serviceman (and usually the most reasonable) is his "know-how." There is no such thing as a "bargain" in radio or TV service for, as we pointed out above, the training, experience and equipment required are too expensive to give away cheaply. The customer should be more wary of the too-cheap serviceman than he is of the too-expensive one.

But of course you don't want to pay more than is necessary, and for your guidance we are reproducing at the end of this chapter a complete schedule of rates for TV service as calculated by a reliable firm. Incidentally, this list includes some items which, having read this book, you can perform yourself, so that you can see how much money you can save yourself.

Although it occasionally happens that a defective under-chassis part *looks* burned, it more often happens that there is no outward sign of the trouble. Like a rotten egg, it looks just like a good one from the outside. In order to locate the offender, the serviceman needs several things: a schematic diagram for this particular set, from which he can identify the parts and the circuits; equipment for testing the parts and circuits to isolate the defective one; and the knowledge and experience which will tell him which tests to make and how to interpret the results.

When he has located the bad actor, if it is a part, he unsolders and removes it and replaces it with a new one. He then tests the set to make sure that his diagnosis was correct and that no further trouble exists.

Troubleshooting procedure

Our purpose in explaining this procedure is to show how it might happen that to replace a resistor—which might cost as little as 10 or 15 cents—the bill could run into several dollars. You will notice that in the table at the end of this chapter, resistor or condenser replacement varies in cost from circuit to circuit between $3.75 and $5.50. This table, incidentally, covers labor only; cost of parts is extra. In addition, the table shows a $3.00 charge for transportation if the work is done in the home and $5.00 if the set is returned to the shop for servicing. Thus, the cost of replacing a 15¢ resistor might vary from $6.75 to $10.50.

The main thing to remember, should you ever have to call a serviceman, is that you're not paying for a resistor or a condenser—you had a set which was not working and you are paying to have it put back in good shape again. If a repair bill such as the above were to accomplish that for you and if the repair were guaranteed, the bill would not be excessive.

On the subject of guarantees, there are two things you should bear in mind: (1) Get an itemized bill for your repair work and a written guarantee. (2) Note whether the guarantee covers only the part or tube replaced, or whether it covers the entire set.

Understand guarantee

Usually servicemen guarantee only their own work. This is a fact often misunderstood by set owners. A most common complaint is that the set went dead, it was repaired, and then it went dead again — therefore (the customer feels) the serviceman should stand behind his work and repair it again free.

Of course this is not so. If you have a flat tire in your car, the serviceman who fixes is not responsible for a future spark plug failure. As a matter of fact, he could hardly guarantee the tire he fixed against another leak or a blowout. The most he could say is that the patch he put on will stand up for a reasonable length of time.

Radio and TV sets are similar in this respect. The trouble is that the average set owner does not know enough about the construction and operation of these devices to distinguish one trouble from another. It is the aim of this book to help the reader distinguish between troubles of different types, know which ones he can attend to himself and which ones require a serviceman. And when a serviceman is required, to know what to expect of him.

The table below gives typical charges for most repairs to your TV set. No serviceman can be held to the charges listed in this table. They are simply representative of average charges, and are offered as a guide for the reader. Note that charges listed are for labor only and do not include parts or transportation.

REPLACEMENT AND REPAIRS

These suggested standard charges cover service only, and include all testing required to locate trouble. Prices for materials used are extra, and are listed in the Catalog of Parts, Accessories, Tubes, and Batteries.

Aerial: repair or orientation, per hour	$ 9.20
minimum	11.50
Aerial: installation or replacement (job price) for standard installation	$17.25 to 23.00
Audio Amplifier: resistor or condenser replacement, wiring repairs	4.05
Audio Transformer: replacement	5.20
Automatic-Frequency-Control System: resistor or condenser replacement, wiring repairs	5.75
Automatic Record Changer: major repair including cleaning, adjustment and lubrication	$7.75 to 13.80
Automatic Record Changer: minor repairs	2.90
Automatic-Volume-Control System: resistor or condenser replacement, wiring repairs	5.20
Beam Bender (Permanent-Magnet Type): replacement or repairs	1.75
Beam Bender (Electromagnet Type): replacement or repairs	4.30
Condenser: main-filter replacement	5.20
Condenser: trimmer replacement	6.05
Condenser: tuning-gang replacement	7.50
Control: replacement	3.75
Damping Circuit: resistor or condenser replacement, wiring repairs	6.05
D-C Restorer: circuit resistor or condenser replacement, wiring repairs	4.30
Deflection Coil: replacement	6.35
Detector Circuit (Audio): resistor or condenser replacement, wiring repairs	4.30
Detector Circuit (Video): resistor or condenser replacement, wiring repairs	4.90
Dial-Drive Cable: replacement	$2.30 to 3.45
Dial-Drive Mechanism: replacement or repairs	3.15
Dial Lamp: replacement	1.15
Dial Pointer: replacement	$1.75 to 2.30
Dial Scale: replacement	3.15
Discriminator Circuit: resistor or condenser replacement, wiring repairs	6.35
Discriminator Transformer: replacement	7.50
Filter Choke: replacement	4.90
Focus Circuit: resistor or condenser replacement, wiring repairs	4.30
Focus Coil: replacement	6.35
Horizontal Circuit: resistor or condenser replacement, wiring repairs	6.05
Horizontal-Output Transformer (Direct View): replacement	7.20
Horizontal-Output Transformer (Projection): replacement	11.50

This Book Will Show the Average Television Set Owner How to Adjust and Repair the Following Faults:—

- Picture long and narrow
- Picture short and fat
- Picture blurred
- Picture has the "jitters"
- Sound and picture not in step
- Ghosts or double image
- Snow - little dots all over picture
- Flashes in picture
- Little black dashes through picture
- Picture Weak, faint, gray
- Pattern over picture
- Tubes lit, but no picture
- Picture keeps rolling
- No picture, only thin white line
- Part of picture on each side of vertical black bar
- No picture, but a jumble of horizontal or diagonal lines or bands
- Pictures are slimmer (but not taller) in center
- Wide, white horizontal band on picture
- Very dark picture
- Can't get sharp picture
- plus many other faults which are explained and advised how to correct in this brand new 1957 Edition

TV REPAIR MANUAL by Edward A. Campbell, A.B.