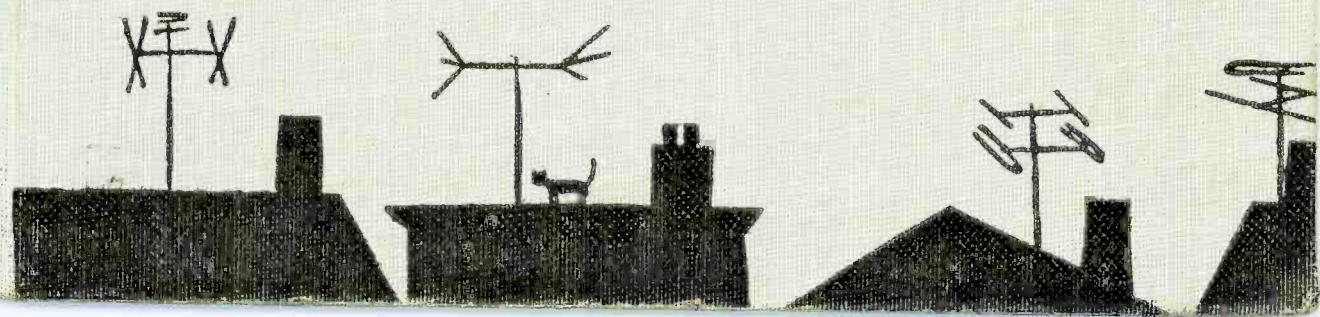
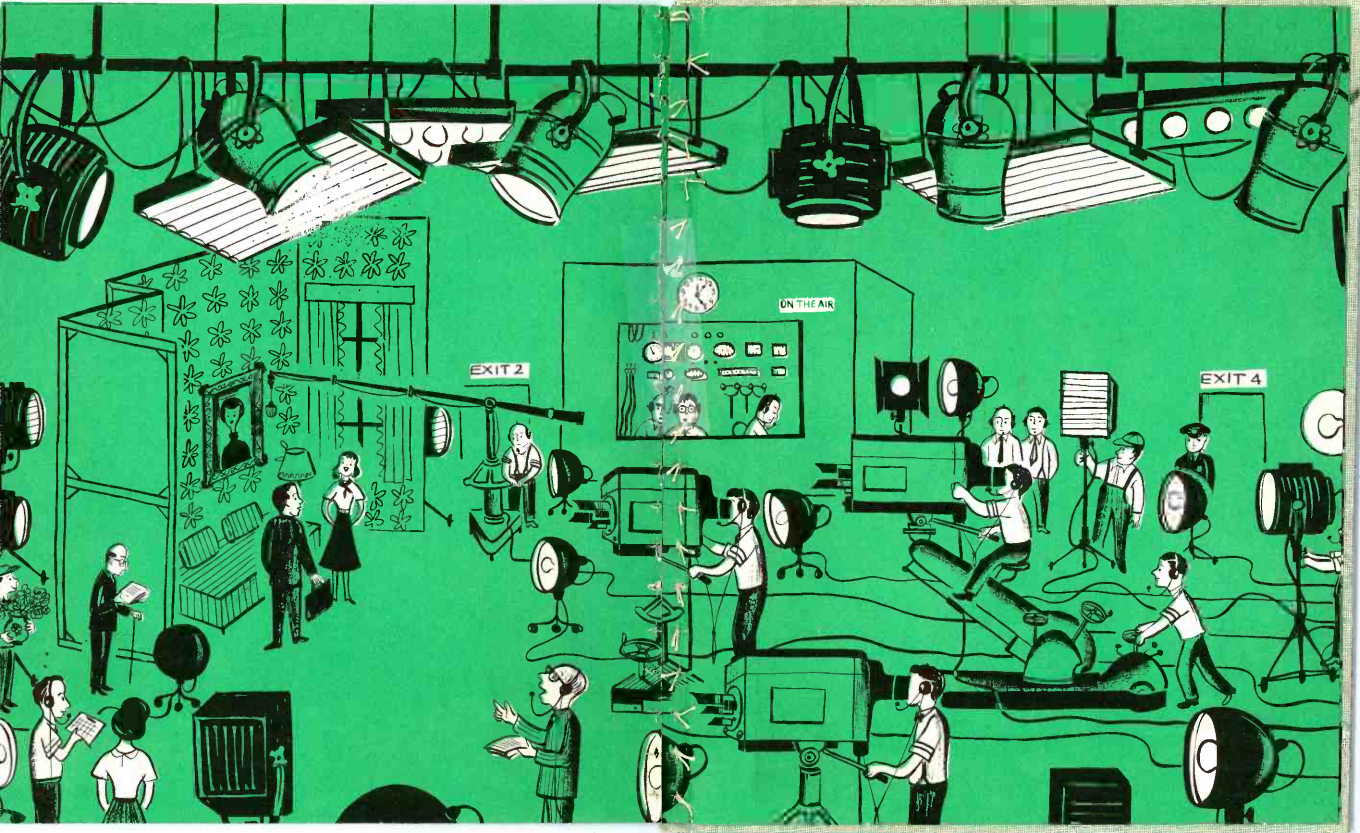
The FIRST BOOK of
TELEVISION

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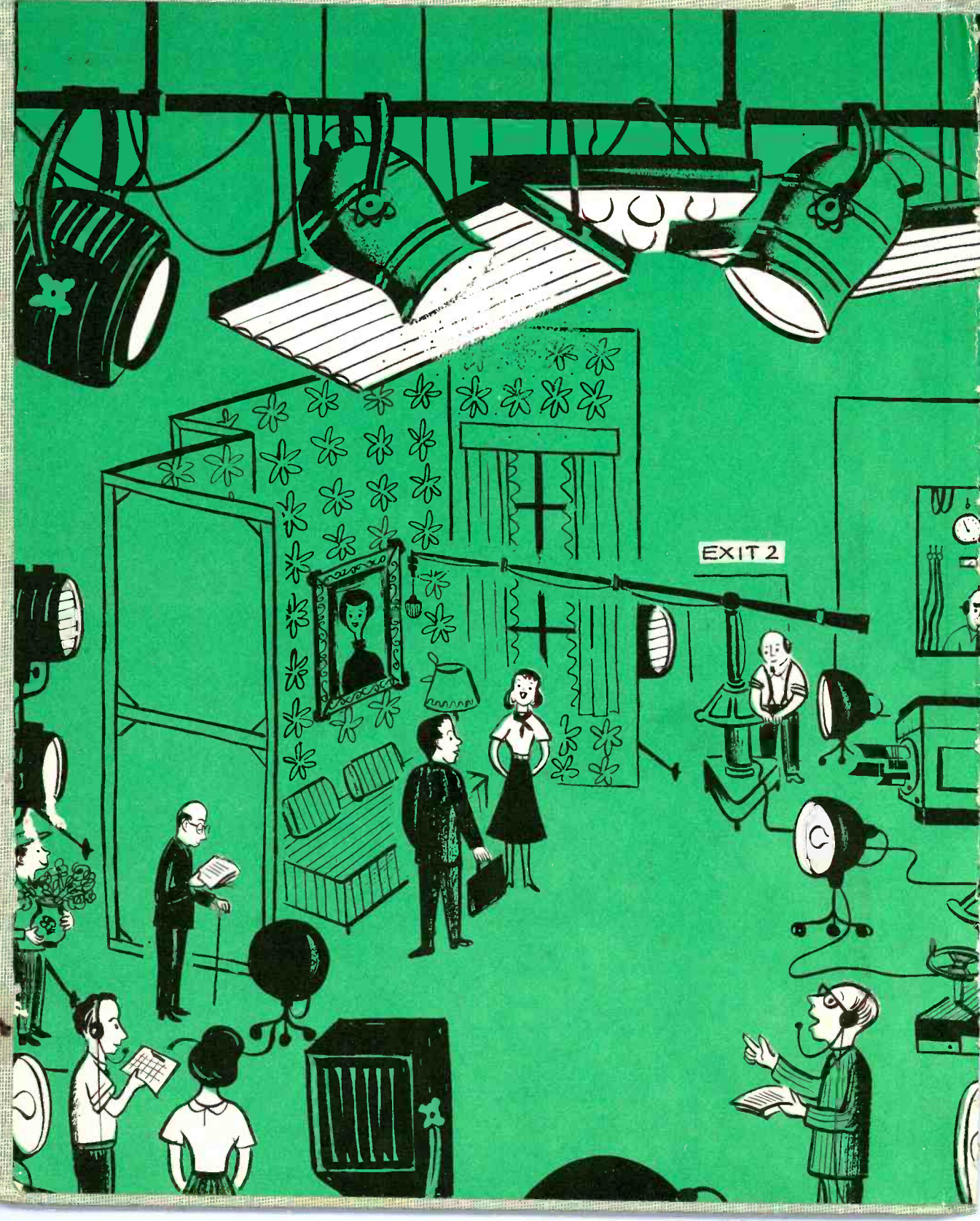
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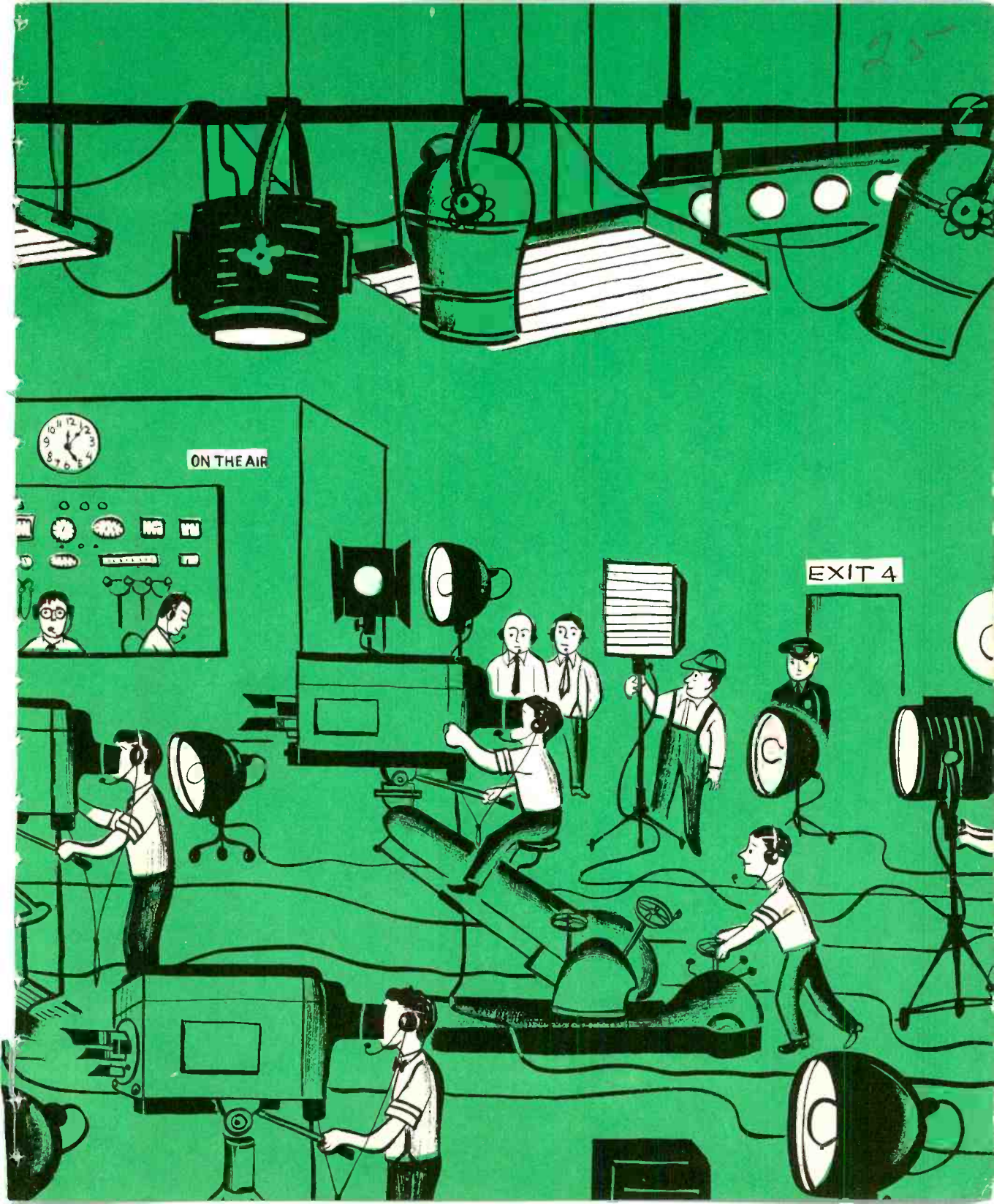
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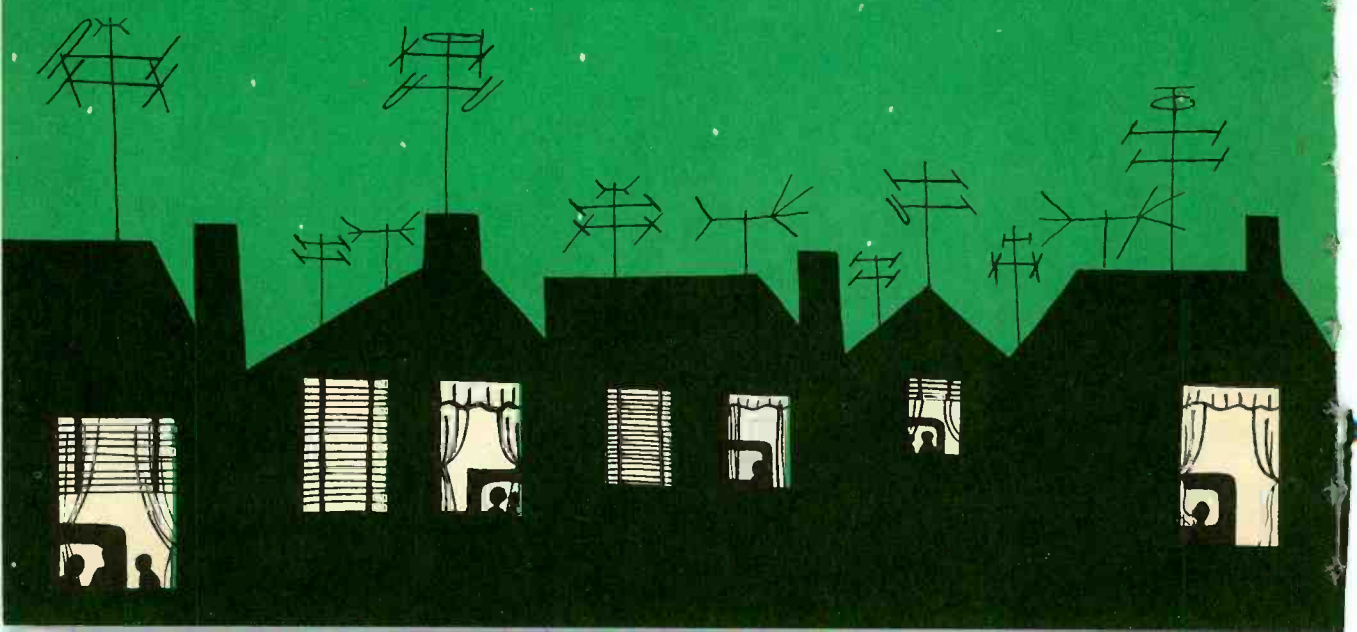

The FIRST BOOK of
TELEVISION

by

EDWARD STODDARD

Pictures by LÁSZLO ROTH

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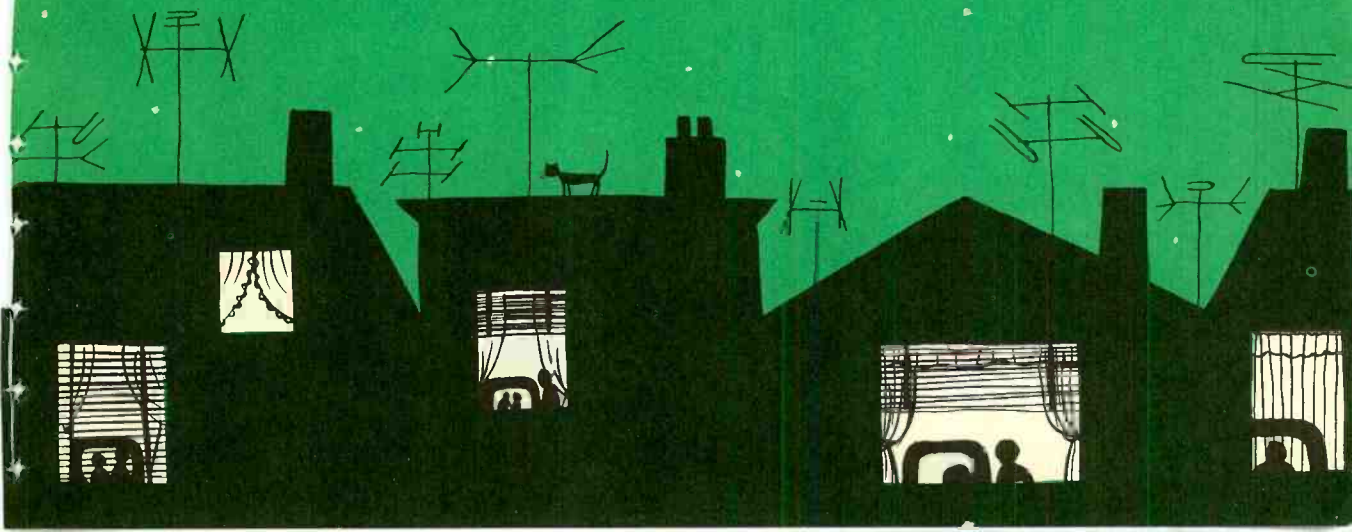
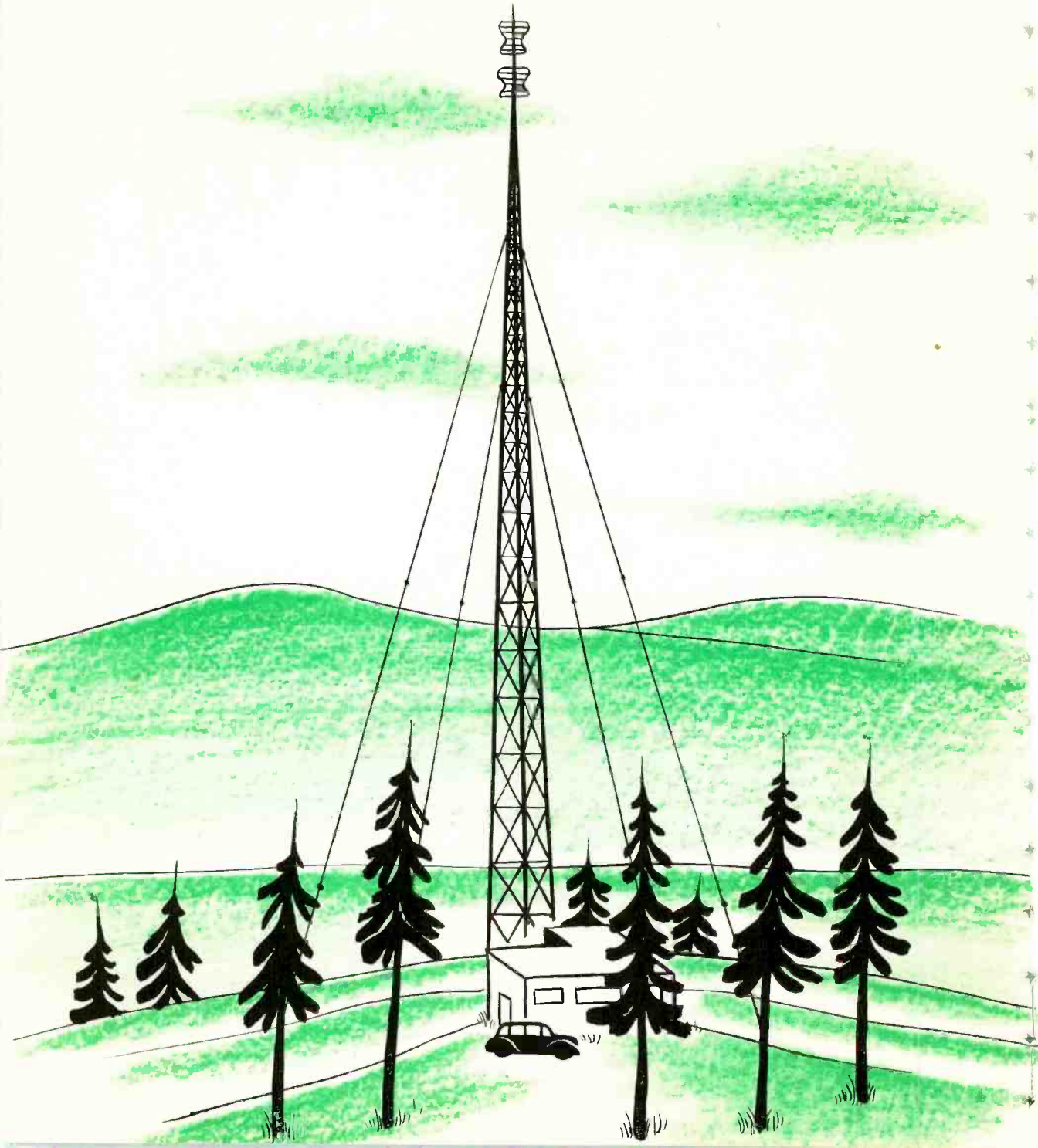
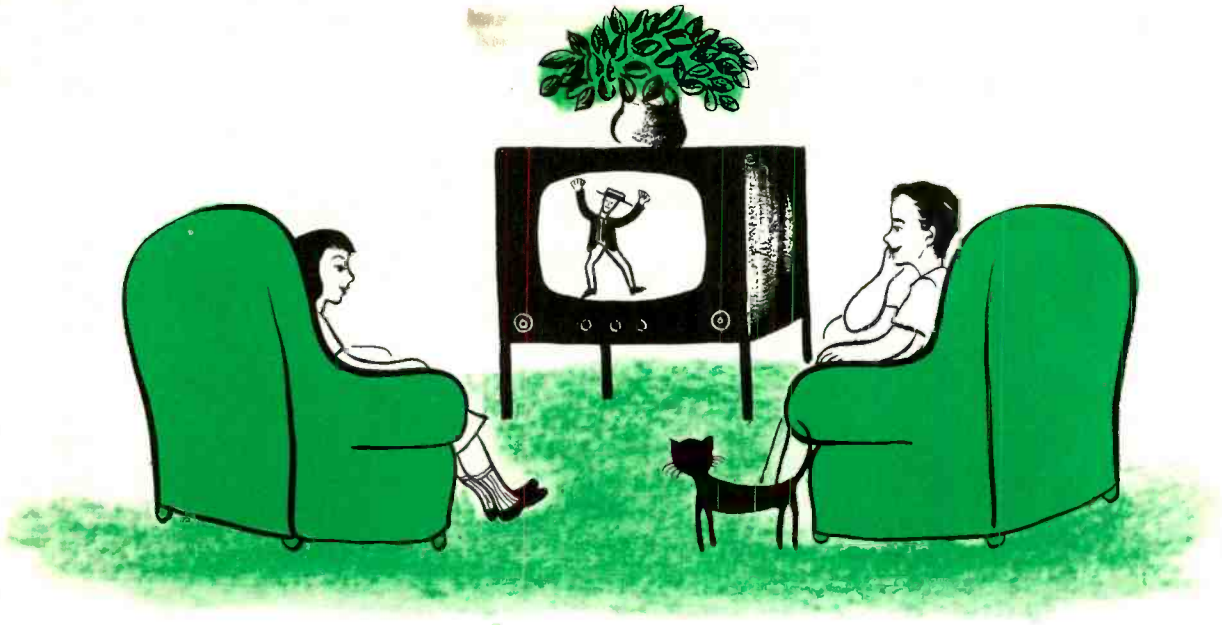






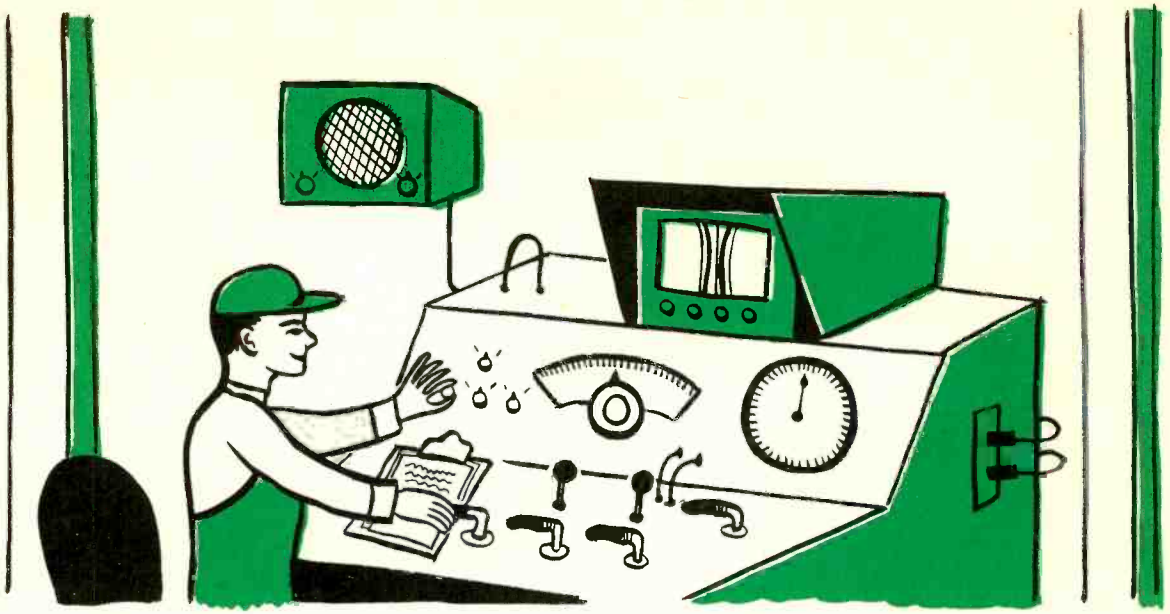
SURPRISING THINGS ABOUT TV

Most families in America today have television sets. Just by turning a dial they can see a baseball game or a movie, a quiz show or a play, or any of hundreds of other programs.

Yet as short a time ago as 1945, few people ever dreamed they would some day have their own private movie theaters.

To most of us television means fun and entertainment and a chance to see important events going on far from where we live.

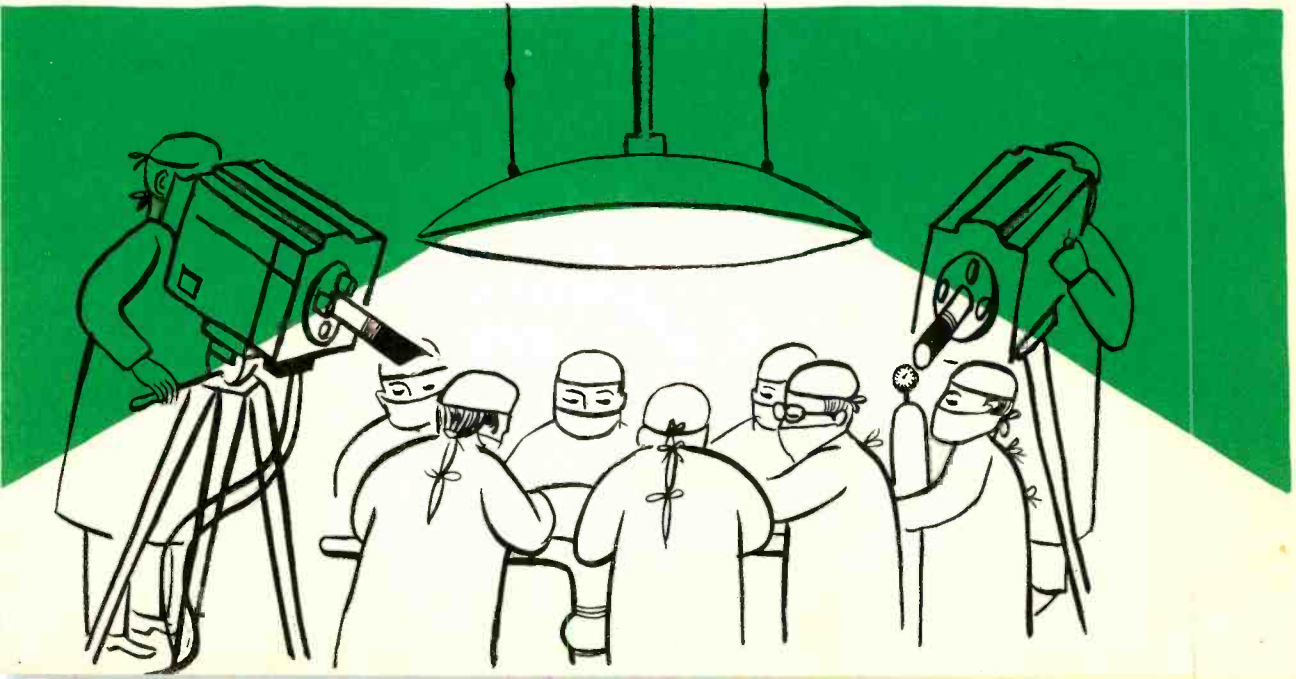
But television has many other uses besides entertainment. It does many difficult jobs in business and industry. The next page shows just a few of these jobs that television does better than anything else can.

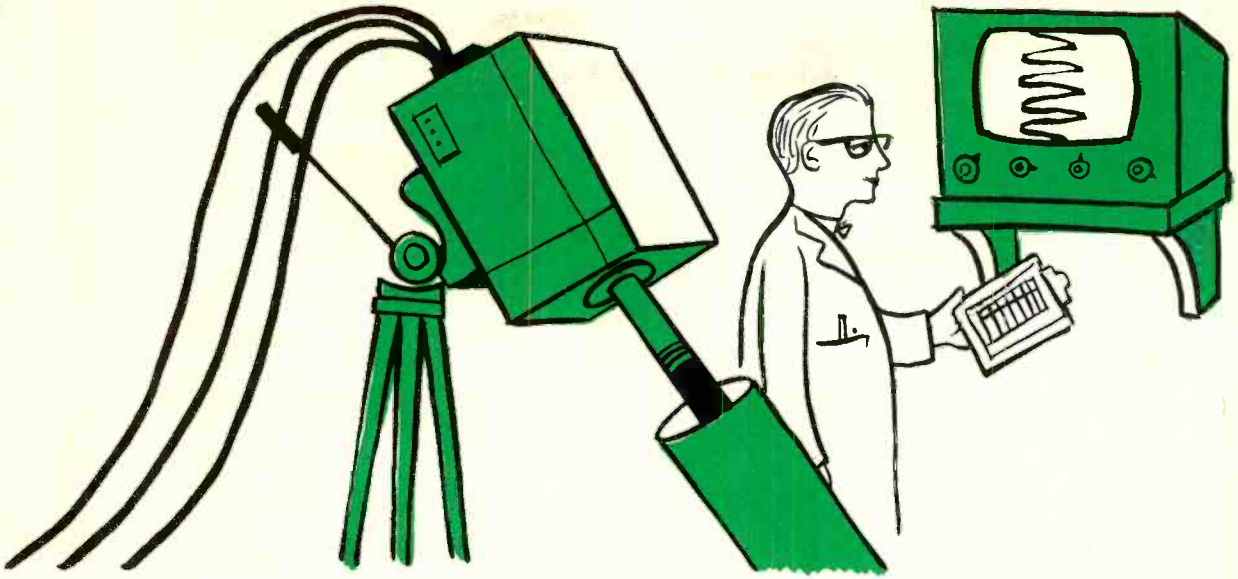


Big factories use television sets to watch parts of machines from places where it would be dangerous for a man to stand.

TELEVISION WORKS FOR SCIENCE AND INDUSTRY, TOO

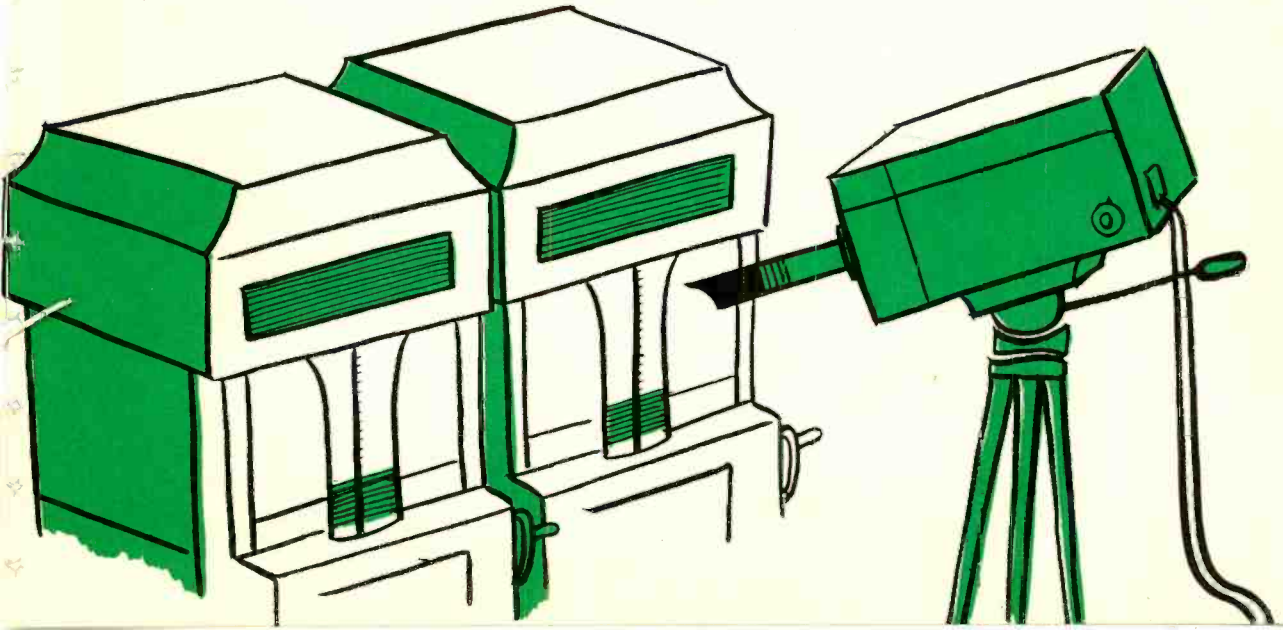
Hospitals use television to show very close views of operations so student doctors can learn how to do them.

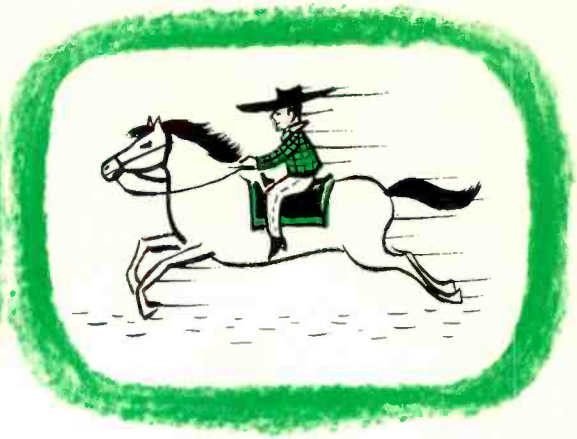




Scientists use television sets to watch things happen in places too small for a man to go, such as the inside of a pipe that is being welded together.

Atomic research laboratories use television to look at experiments with dangerous chemicals which a man would not dare go near.





WHY A TELEVISION PICTURE SEEMS TO MOVE

A television picture seems to move for the same reason that moving pictures seem to move.

Have you ever seen one of those little booklets that you flip very quickly while you watch the pictures? Instead of many pictures, each one a little different, you seem to see one picture that moves.

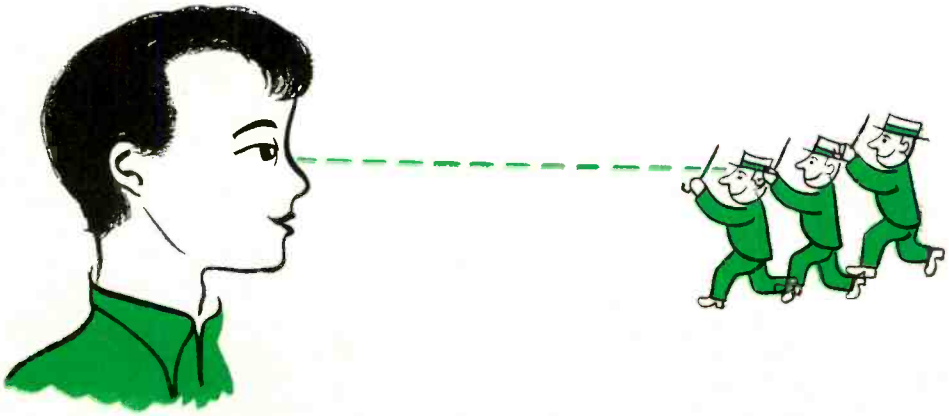
Television and moving pictures are just like the pictures in the little booklet. They do not really move at all. Each picture is just a little different from the picture before it. If you see them one right after another fast enough, they blur together and seem to make one picture that moves.

That is because your eyes are very easily fooled. If the pictures are changed faster than ten times a second, you can't see the separate pictures at all. Your eyes are still seeing one picture while the next is being shown. They can't tell pictures apart that fast. Instead of seeing one picture and then another, they just give up.

"The picture must have moved," your eyes tell you.

And so the picture seems to move, while really it is just a lot of pictures changed so quickly that your eyes can't follow.

Television pictures change thirty times every second. If you see a one-hour show, you have really seen 108,000 separate pictures!



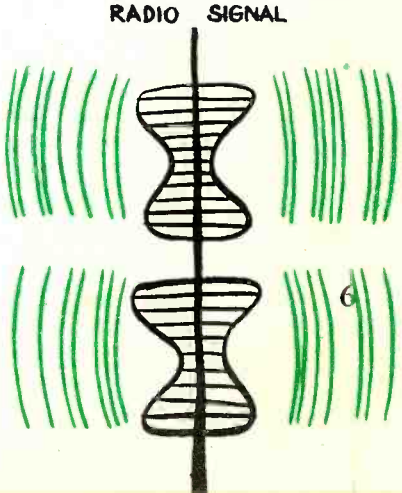
MECHANICAL TELEVISION

Television is not as new an invention as most people think. It was invented even before radio.

The first television pictures went over a wire, instead of over a radio wave, as they do today. They were not very good. They were more like silhouettes than pictures. But they traveled through space from one place to another, and they moved.

The method used to send those first television pictures was quite different from modern television. But the way the pictures were broken down so that they would travel over a wire was very much the same.

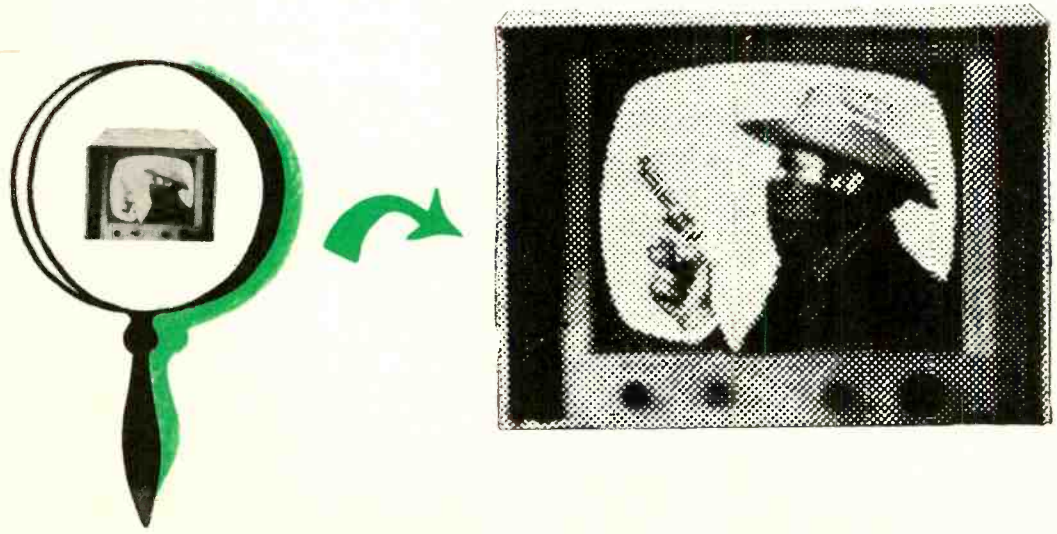
Before a picture can travel over a wire or a radio wave, it has to be turned into "signals." A "signal" is a sign, or message. Indians sent signals with smoke. Railroads use colored lights for signals. Television makes signals with electric currents. Each tiny bit of the picture has to be made into an electric current, or television signal.

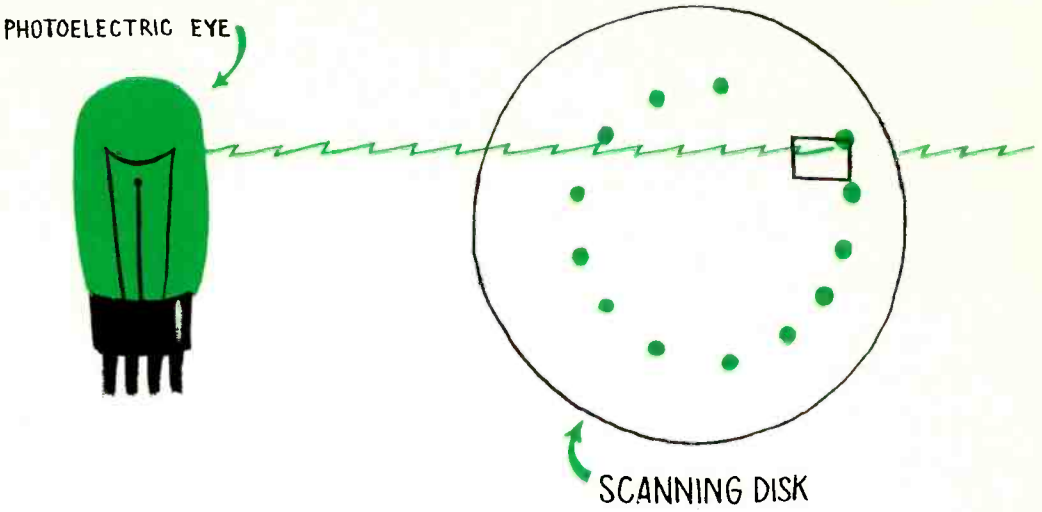


A wire, or a radio wave, can carry only one signal at a time. Yet a picture is made up of hundreds of bits of light and dark. A single hand has dozens of shades of white, gray, and dark gray.

You can fool the eye about color, just as you can about motion. Look very closely at a newspaper photograph. Use a magnifying glass if you have one. You will see that the picture is printed with hundreds of tiny dots of different sizes so close together that they blend together when you look at them from a little distance.

A television picture has to be changed into dots like a newspaper photograph, and then the dots have to be changed into electric currents that can be sent, one by one, to the receiver. Then the receiver has to put the dots together again so that they look like a picture.





THE SCANNING DISK

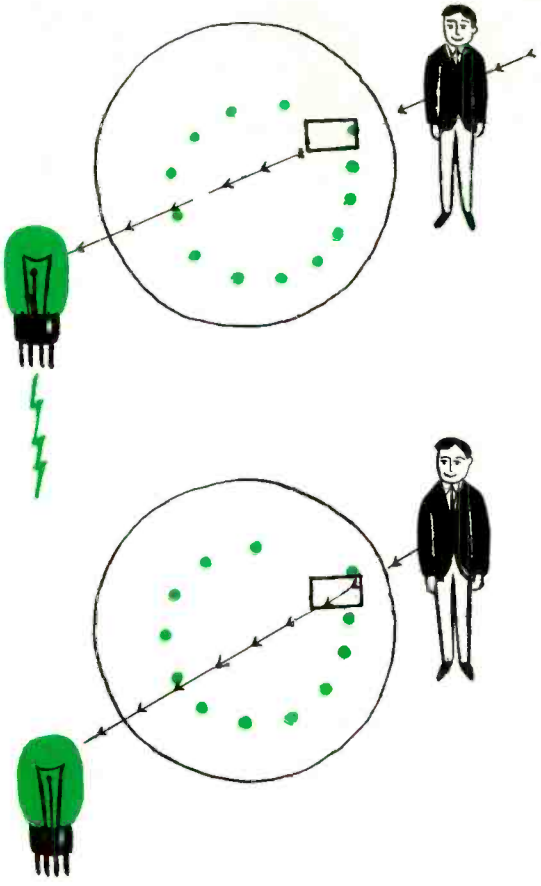
The way this was first done was by means of a "scanning" disk. To "scan" means to look closely in any regular order at each part of a thing. The scanning disk looks at the picture in a regular order.

There are holes in the scanning disk, each just a little closer to the center than the one behind it. Behind the disk is a special kind of bulb called a "photoelectric eye." This bulb does a very unusual job. It starts an electric current flowing when light hits it.

If no light hits the bulb, no current flows. If a little light hits it, a weak current flows. If a strong light hits it, a strong current flows.

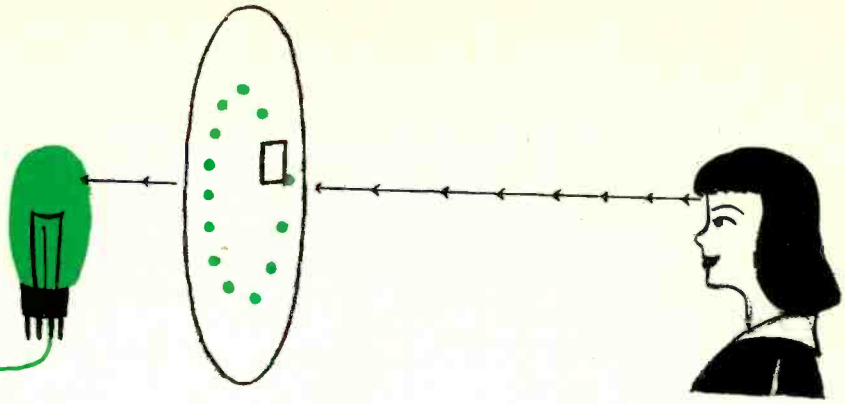
The scanning disk is between the "eye" and the person whose picture you want to send. The disk begins spinning. The first hole, the highest one, moves between the person and the "eye."

MAKING THE SIGNAL



Suppose the person is standing against a white sheet. When the hole and the "eye" line up with the sheet, the bright reflection of the white cloth goes through the hole and hits the "eye." The "eye" starts a lot of current flowing over the wire toward the receiver. But as soon as the hole lines up with the person's black hair, no light reaches the "eye." Black does not reflect any light, so the "eye" stops the current. As soon as the hole lines up with the sheet on the other side, the bright reflection hits the "eye" and current starts flowing again.

By the time this first hole reaches the edge of the picture, the second hole begins to move across. When it has finished, the third hole begins. It keeps on like this until the lowest hole has finished. Then the highest hole begins again.



Whenever a hole is lined up with the "eye" and the person's skin, a medium amount of light is reflected and a medium amount of current flows. When a hole lines up with dark clothes, less current flows, but more than when no light at all hits the "eye."

What the scanning disk and "eye" have done is change the picture of the person into an electric current that flows strongly over the wire when it is carrying a light dot of the picture, less strongly when it is carrying a gray dot, and does not flow at all when a black dot is to be sent. These strong and weak currents keep in strict order, just the way they were picked up by the scanning disk. Each part of the current is a signal for one dot in the picture.

RECEIVING THE PICTURE

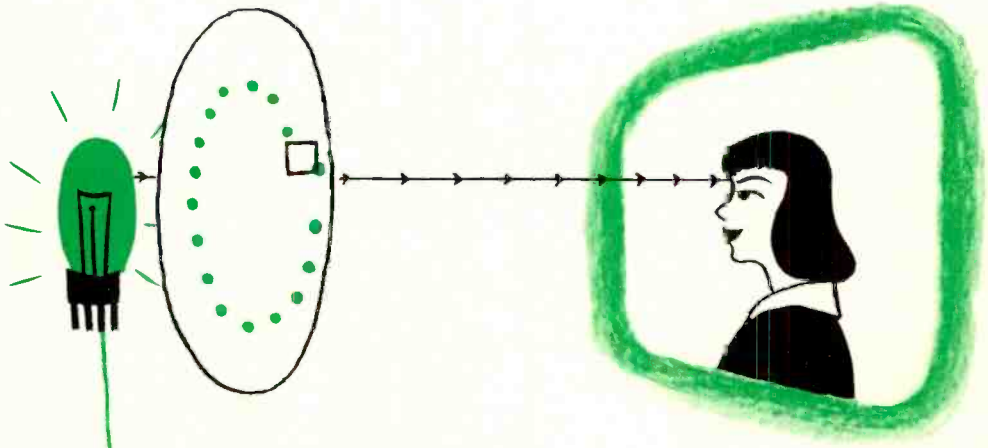
Now the dots have to be made into a picture again. It is almost exactly the opposite of what happened with the eye and the scanning disk. The electric current has to be turned back into dots and the dots have to be made into the picture.

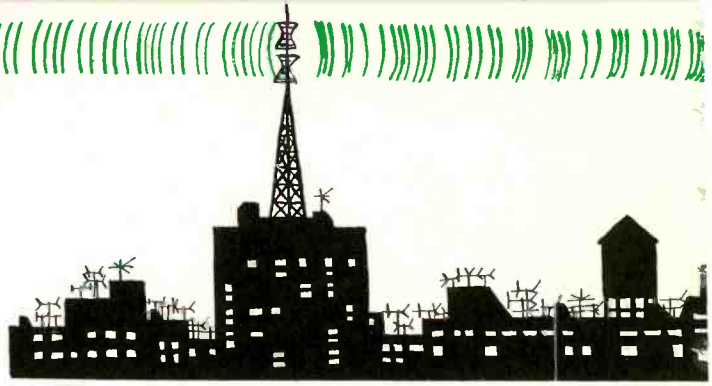
There is another disk in the receiver. It has exactly the same holes in the same places as the scanning disk, and it must spin at exactly the same speed.

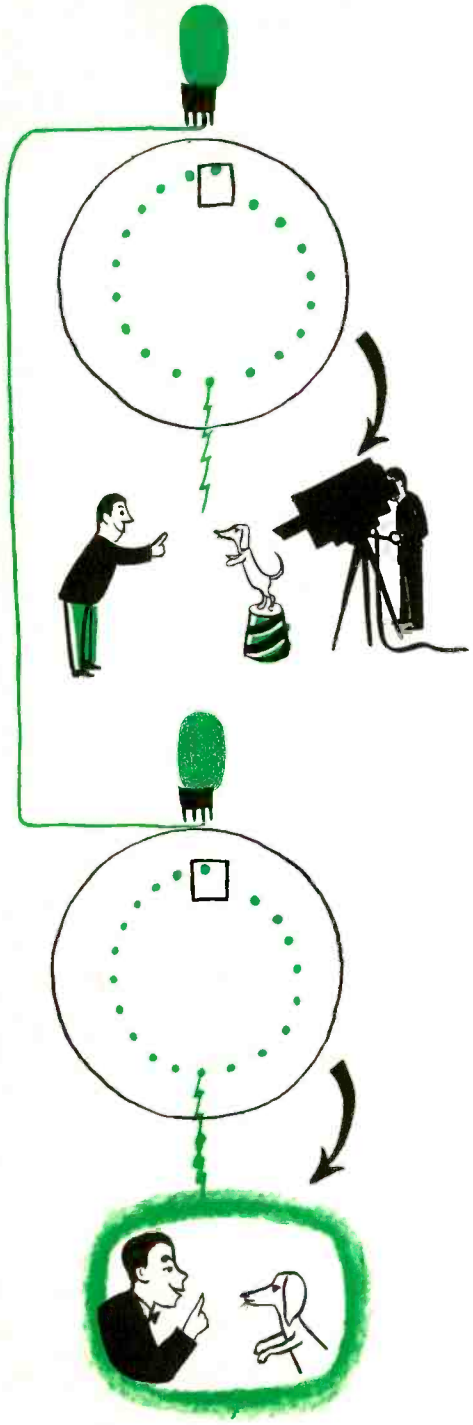
Behind this disk is a special light that burns more brightly as more current runs through it. The current from the "eye" comes to this light.

Now here is the hard part. When the current that the "eye" started reaches this light bulb, the hole in the disk in front of it must be in exactly the same place as the hole in the scanning disk was when the "eye" started the current.

The light shines through the hole on the disk against a white screen.

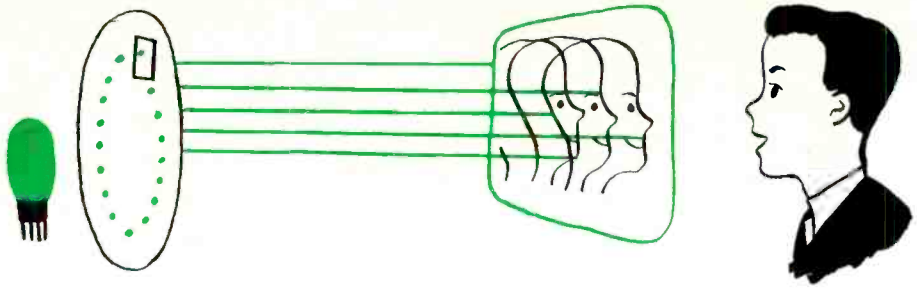






Now do you see how this mechanical television works? When a hole on the scanning disk lets the light from a white part of the picture to be sent reach the "eye," the current makes the bulb in the receiver burn brightly. The hole in the receiver disk is in the same position as the hole in the scanning disk. The bright light of the bulb shines on the screen in exactly the same place that is white on the picture to be sent.

If the scanning disk is lined up with a dark part of the picture to be sent, very little current is sent by the eye. The bulb burns dimly in the receiver. Very little light shines through the hole on the receiving disk. That part of the receiving screen is dark.

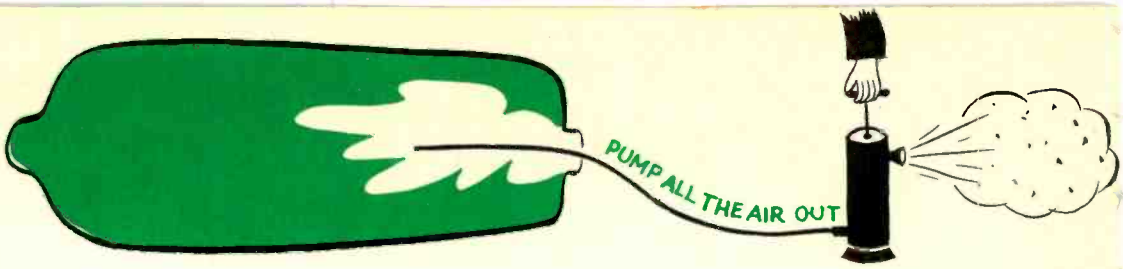


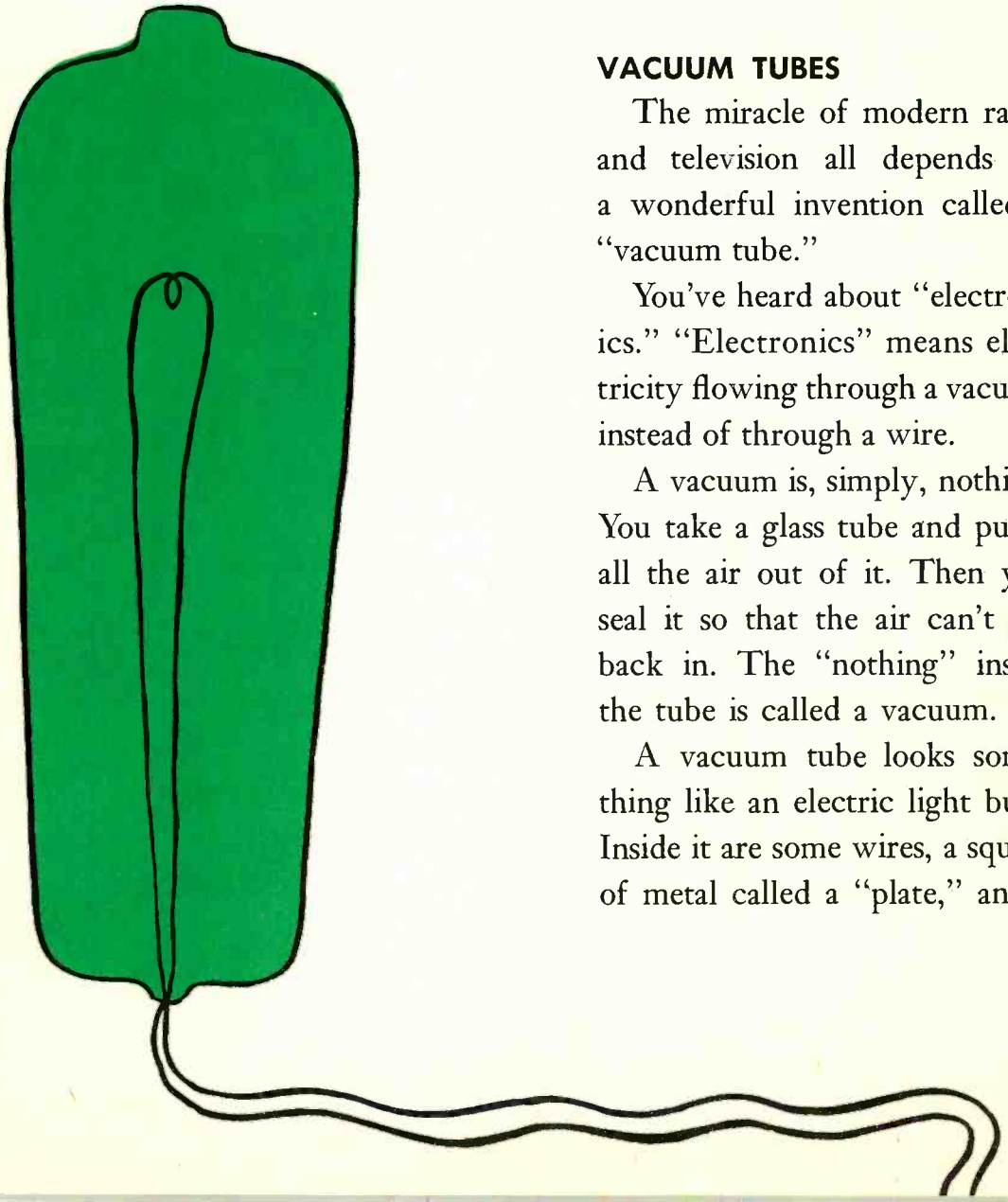
Even though the dots are shown one at a time, they are shown so quickly that your eyes are fooled and you see them all at once, because your eyes keep seeing a thing for a tenth of a second after it is gone. It is the same way in which you seem to see a "moving" picture.

The scanning and receiving wheels have to turn fast enough to fool the eye into seeing "moving" pictures, so they have to spin at least ten times a second. No matter how much the picture that is being sent might change, each picture is still just an unmoving picture built up of the little light and dark dots ten times a second. Each picture is just a little different. And the person watching thinks it is moving.

Mechanical television was not very successful. It was too hard to get the disks to spin at exactly the same speed, with the holes on both disks in the right places at the right time.

Modern television uses this same method of looking at one part of the picture at a time and sending a signal to the receiver to tell it whether a dot is white, black, or somewhere in between. But modern television goes by radio waves instead of wires, and the sending machine and the receiver do their work without any moving parts at all.





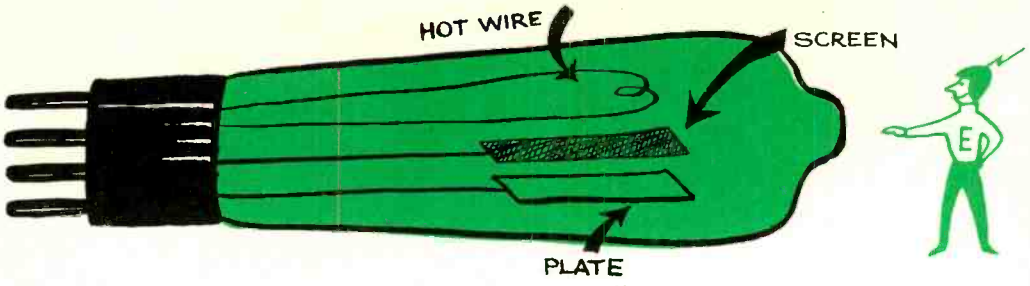
VACUUM TUBES

The miracle of modern radio and television all depends on a wonderful invention called a "vacuum tube."

You've heard about "electronics." "Electronics" means electricity flowing through a vacuum instead of through a wire.

A vacuum is, simply, nothing. You take a glass tube and pump all the air out of it. Then you seal it so that the air can't get back in. The "nothing" inside the tube is called a vacuum.

A vacuum tube looks something like an electric light bulb. Inside it are some wires, a square of metal called a "plate," and a



fine metal screen. You pump all the air out of the tube and seal it so that no more air can get back in. Now the wires and the plate and the screen are in a vacuum.

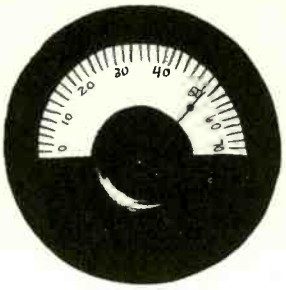
It is very hard to make electricity jump off a wire outside a vacuum because the air pushes it back. But in a vacuum there is nothing to keep it on the wire. You can make it jump right off and fly around in the vacuum.

You do this by making the wire hot, just as you make an electric bulb filament hot. The heat makes tiny bits of electricity jump off the wire. These bits of electricity are called "electrons."

THE PLATE

The square of metal called the "plate" is beside the hot wire. There is always some electricity in a metal. If you pull it out, the metal will attract any nearby electrons. So you pull electricity out of the plate and push it into the hot wire through the wires that connect them.

Because you have pulled electricity out of the plate, the plate begins to attract the electrons that jumped off the hot wire. Now you have an electric current flowing, not only through the wire, but right through the vacuum, too!

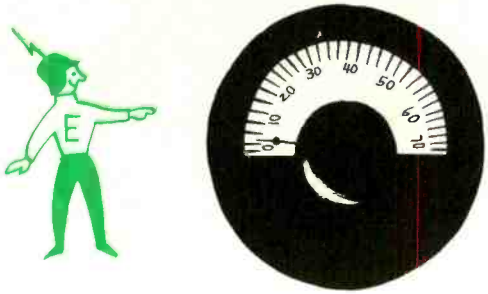


THE ELECTRONS ARE PUSHED AWAY

THE SCREEN

The screen is between the hot wire and the plate. It is just like a window screen, but has much smaller holes. There is a wire leading out from the screen. If you push electricity into the screen through this wire, it pushes away the electrons jumping off the hot wire. The electrons cannot reach the plate because the screen is between them.

If you pull electricity out of the screen, it pulls on the electrons from the hot wire. It pulls so hard that most of the electrons fly right through the holes and go into the plate. And much



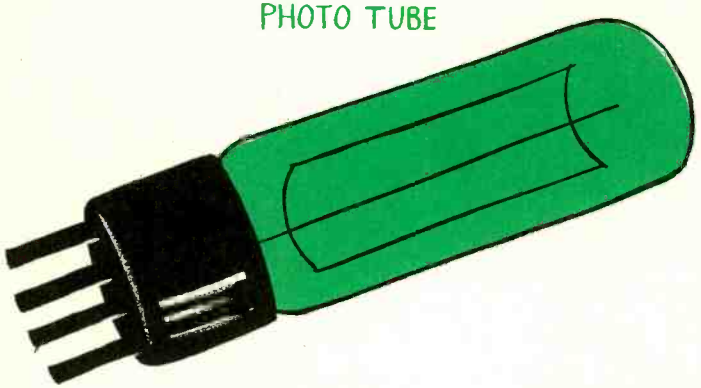
more electricity flows between the hot wire and the plate than if there were no screen between them. Just a small change in the amount of electricity in the screen makes a great big change in the amount of electricity flowing from the hot wire to the plate.

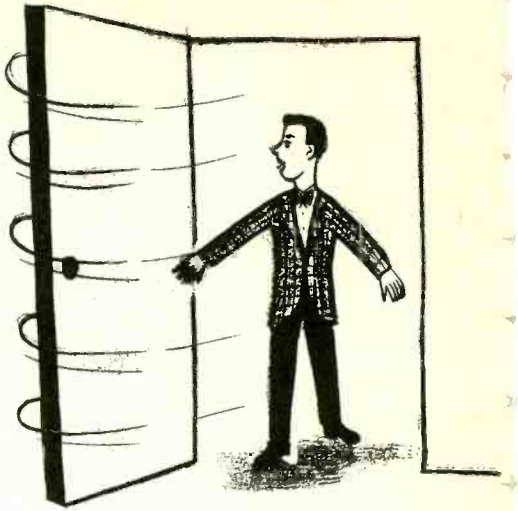
The vacuum tube has now become a sort of valve. Just as you can control a lot of water with just a little force on the handle of a faucet, the vacuum tube controls a lot of electricity with just a little electricity.

That is how radio tubes take weak signals and "amplify" them, or make them strong.

VACUUM TUBES DO MANY IMPORTANT THINGS

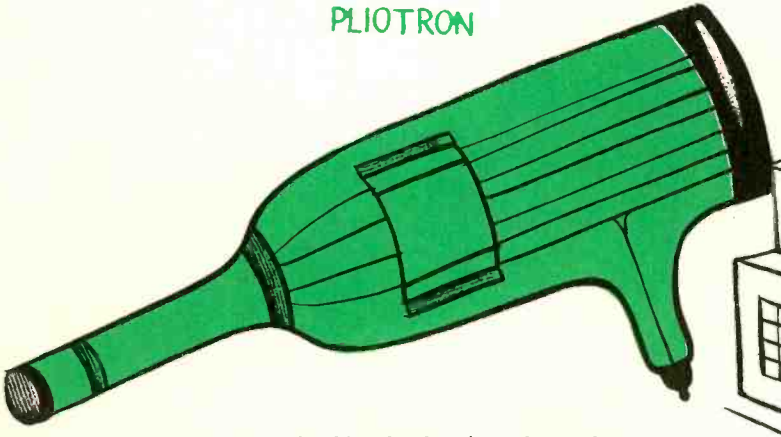
PHOTO TUBE

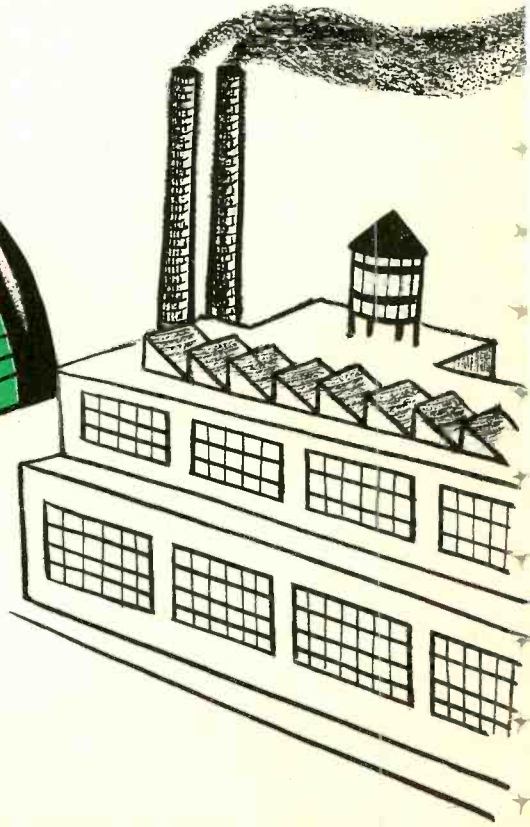




A vacuum tube that looks like this opens doors automatically.

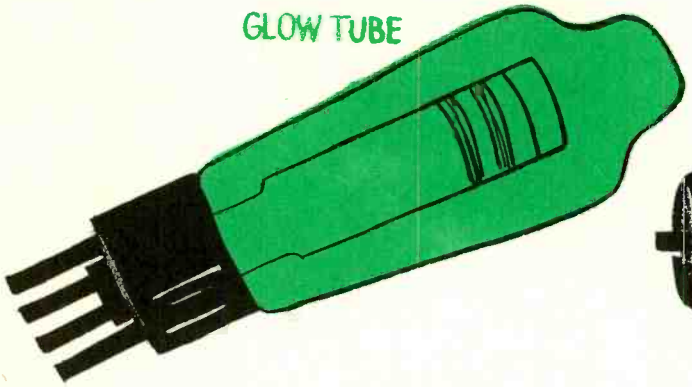
PLIOTRON

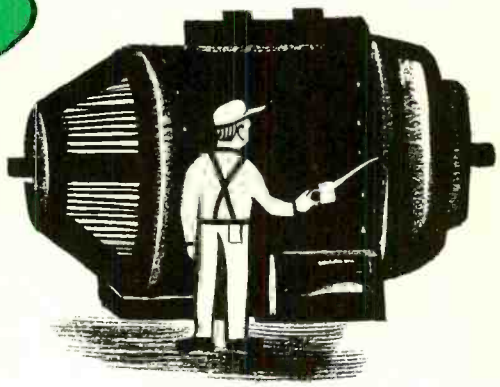




A vacuum tube like this hardens the surfaces of machine parts in production in just a few seconds.

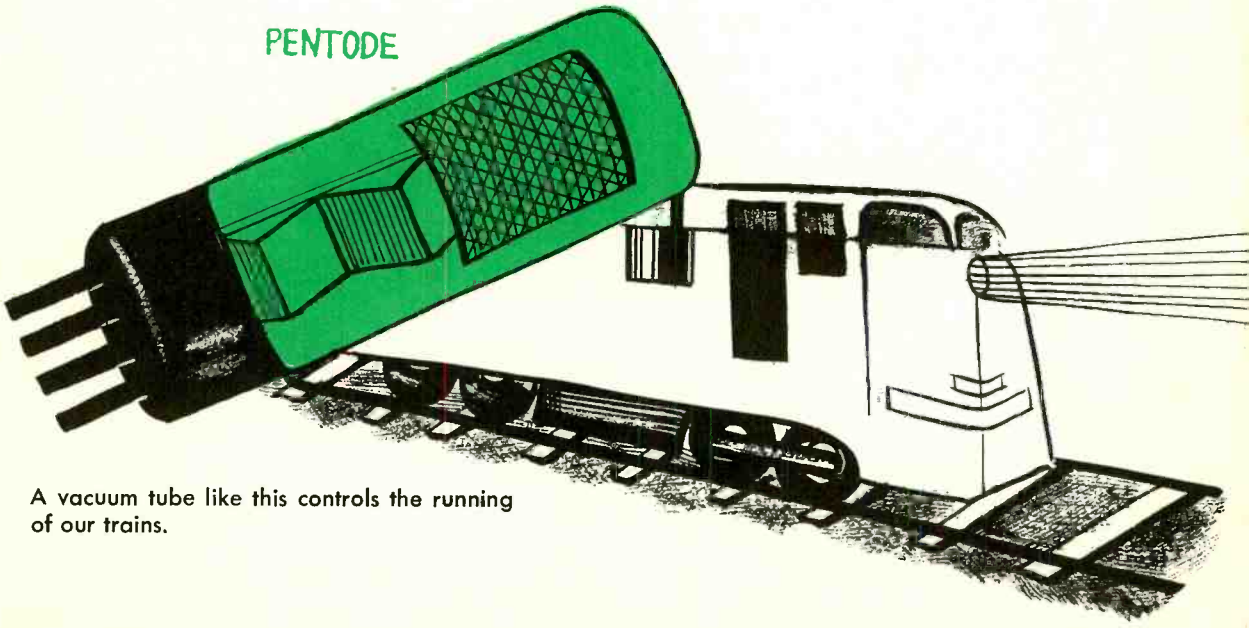
GLOW TUBE



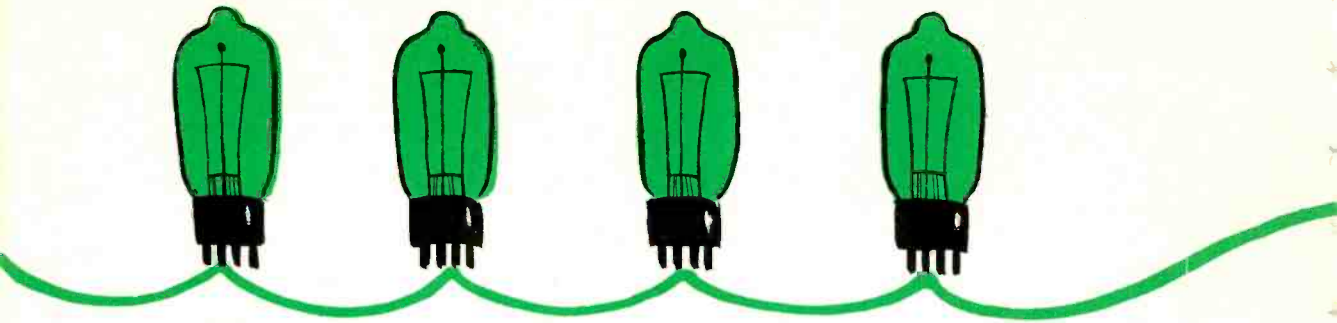


A vacuum tube like this makes it possible for motors to run at the same speed whether they are carrying a heavy load or a light one.

PENTODE



A vacuum tube like this controls the running of our trains.



RADIO TUBES MAKE TELEVISION SIGNALS STRONGER

VACUUM TUBES AND TV

In the mechanical television set, the signal that told the receiver whether a part of the picture should be white or black or somewhere in between was the amount of current that flowed in the wire between the sender and the receiver.

If you put that weak signal into the screen of a radio tube, the screen will make a much stronger change in the amount of current that flows from the hot wire to the plate. Much more current will flow from the hot wire to the plate than the television sender started. The changes will be much stronger than the changes from the sender, and all the changes will be at the right times and in the right amounts, because they are controlled by the signal on the screen.

Now the current from the radio tube becomes the signal, many times as strong as the original signal from the sending set. By the time several tubes have done this, the signal may be hundreds of times as strong as when it started, strong enough to run big loudspeakers, or big television tubes.

Modern or "electronic" television, by using a wonderful vacuum tube called a "camera tube," does what the scanning disk did, but without any moving parts at all.

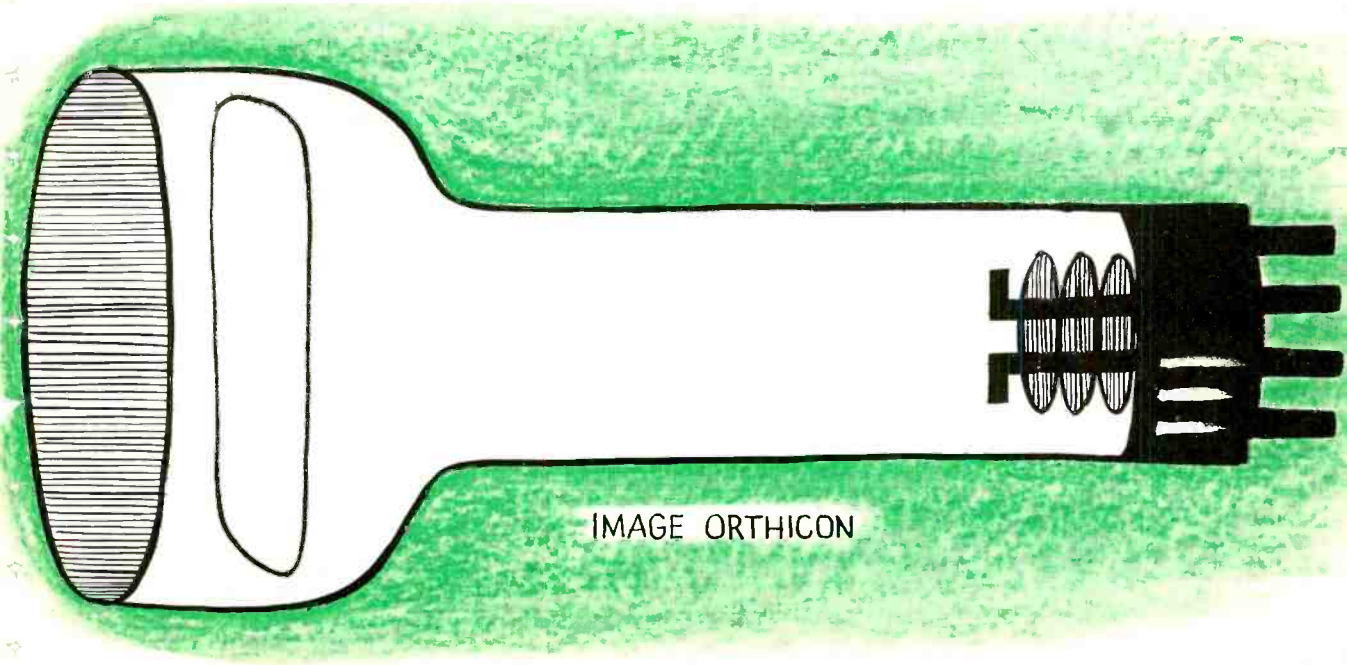
THE CAMERA TUBE

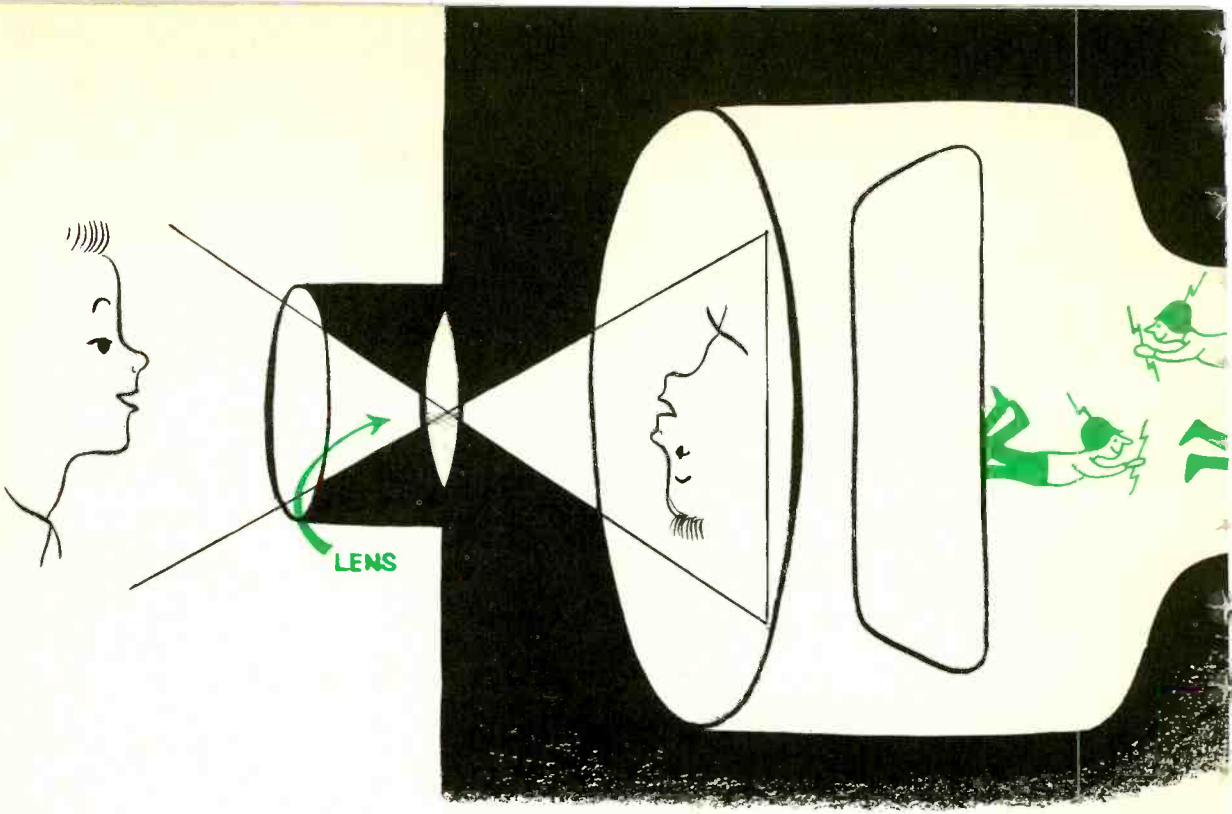
Television uses several different kinds of camera tubes. All of them have big names. You will hear of "Iconoscopes," "Orthicons," and "Image Orthicons."

These words come from Greek words that mean "picture" (icon), "tube" (scope), and so on.

All these camera tubes scan the picture to be sent.

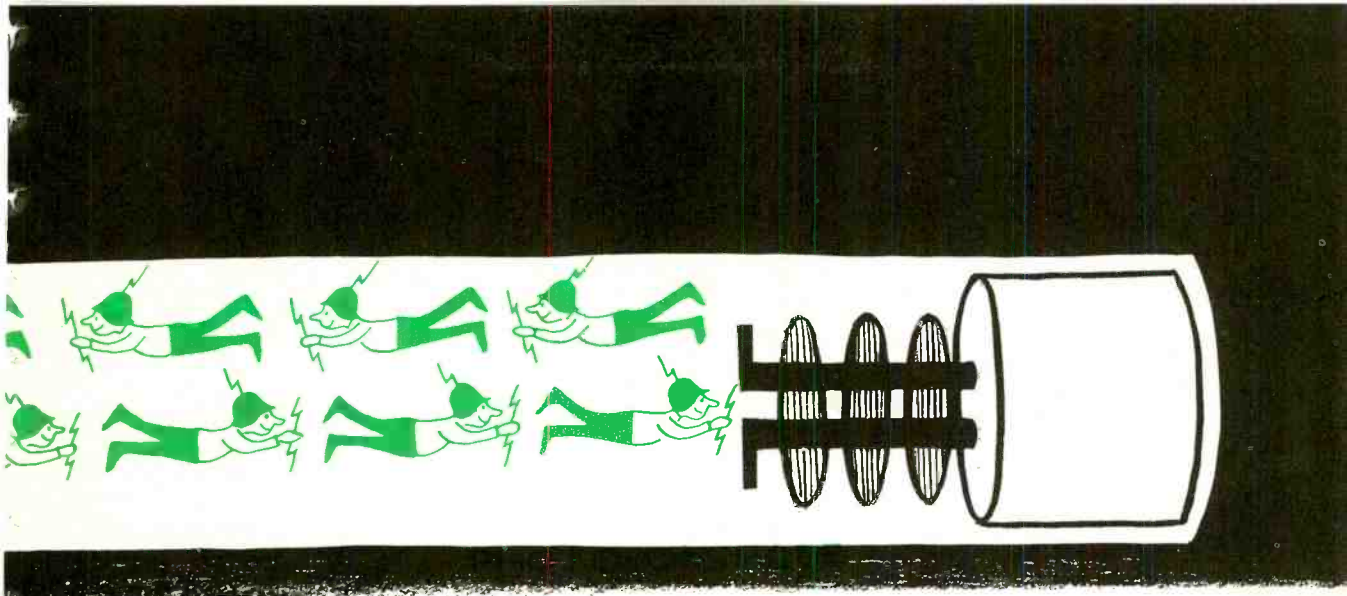
The camera tube used most often is the Image Orthicon. "Ortho" means "straight." "Icon" means "picture." "Orthicon" means "straight picture." "Image" means that it is a different kind of tube than a plain Orthicon.





The Image Orthicon is the kind of camera tube used most because it can "see" with less light than the other kinds of tubes. Before it was invented, television actors had to work under very bright, hot lights. Outdoor events, such as football or baseball games, could not be televised at all. It is the Image Orthicon that makes it possible to televise events with very little light.

The Image Orthicon is a big vacuum tube. It is inside the television camera. There is a lens in the camera that throws a picture of the scene to be televised on the end of the tube, just as a camera lens throws a picture on the film.



This picture is upside down, but that is not important because your receiver can easily turn it right side up by working the timing of the scanning backwards.

THE PHOTO CATHODE

At the end of the tube where the picture is thrown is a device called a "photo cathode." "Photo" means "light." "Cathode" is the name for a part that kicks out electrons, or bits of electricity. The hot wire in a radio tube is a cathode.

This photo cathode does a very peculiar thing. When light hits part of it, that part starts kicking out electrons. It is just as if that part of the cathode had become a hot wire.

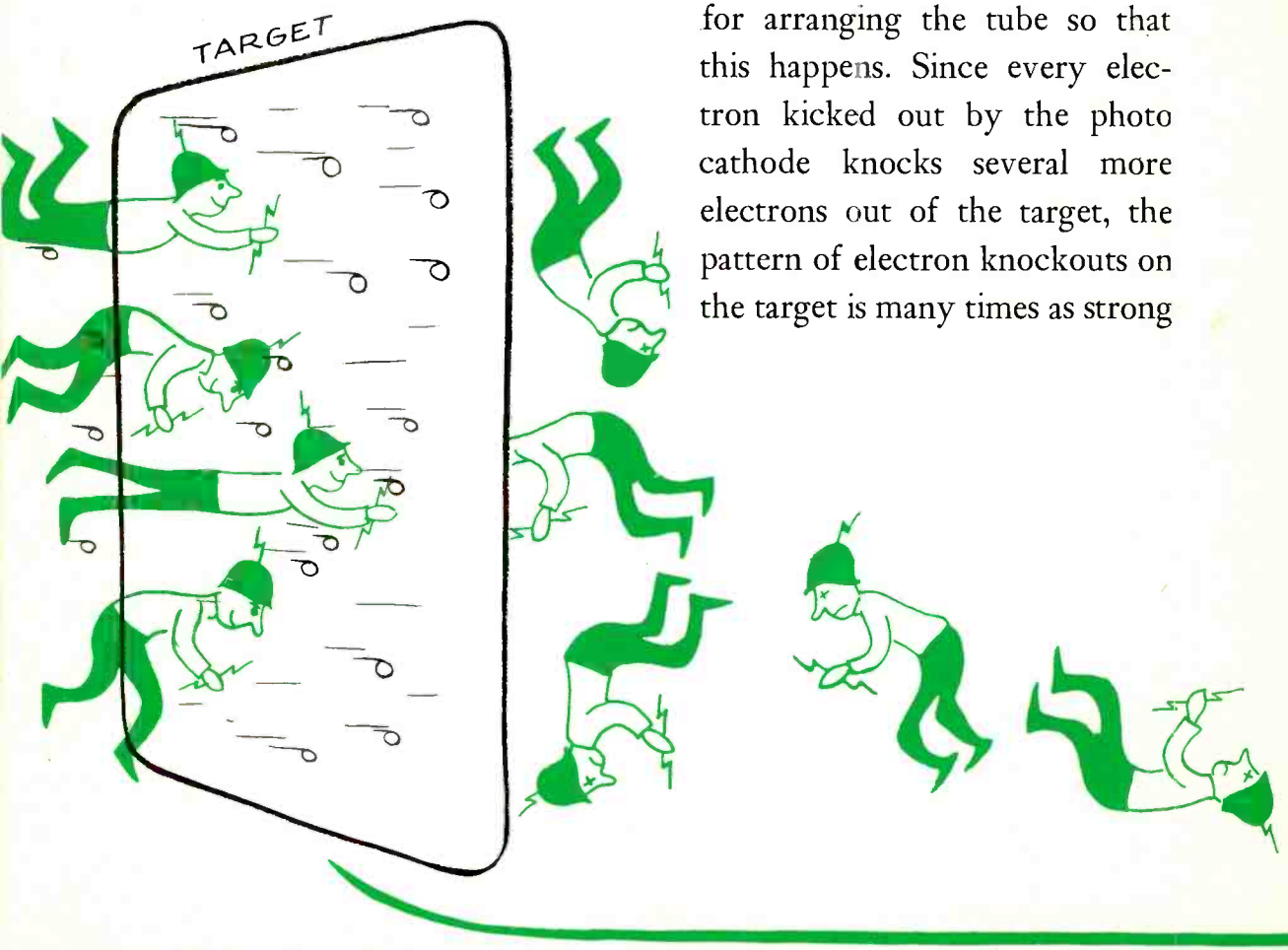
The parts of the photo cathode that are in a white part of the picture kick out a lot of electrons. The parts that are in a gray part kick out a few electrons. Those that are in a black part of the picture hang on to their electrons.

THE TARGET

Inside the tube, behind the photo cathode, is a part called the "target." All the electrons kicked out by the photo cathode fly over and hit the target.

These electrons from the photo cathode hit the target so hard that they bounce right back off. And each one knocks several more electrons out of the target where it hit.

There is an important reason for arranging the tube so that this happens. Since every electron kicked out by the photo cathode knocks several more electrons out of the target, the pattern of electron knockouts on the target is many times as strong



as it was in the photo cathode. This is one reason why the Image Orthicon can "see" with so little light.

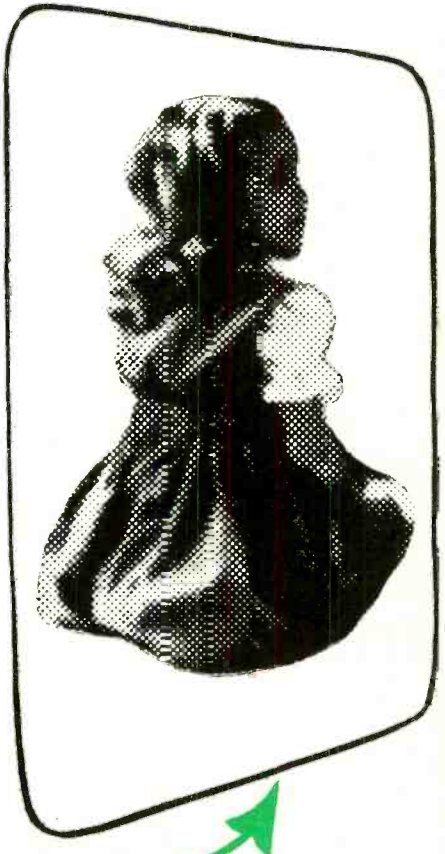
THE ELECTRON PICTURE

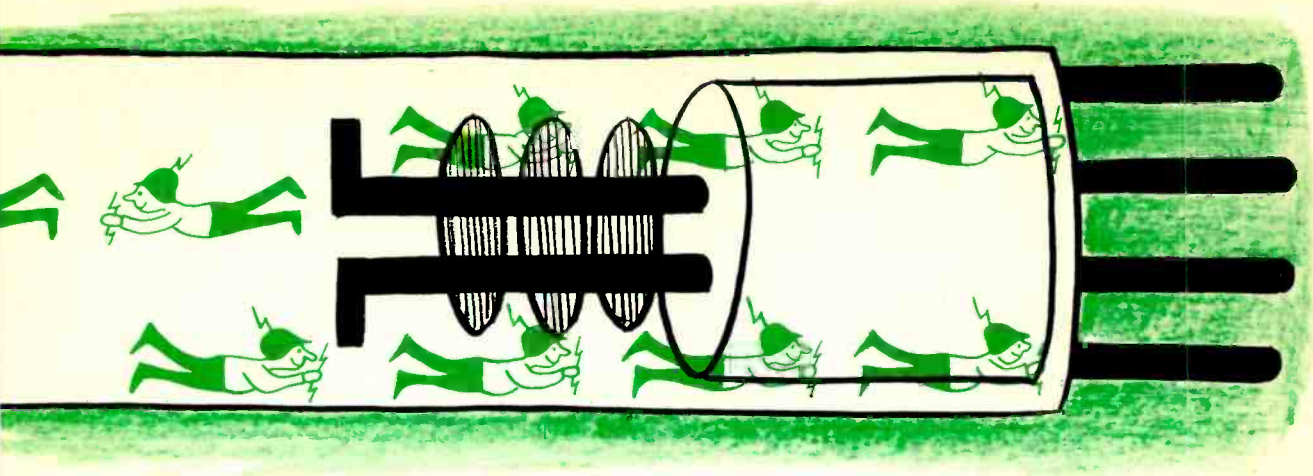
All this kicking out and knocking out of electrons has left a pattern on the target which is really an "electron picture" of the light picture the lens threw on the photo cathode.

Whenever the picture was white, a lot of electrons have been knocked out of the target. Where the picture was gray, there are still a lot of electrons in the target.

This electron picture will be turned into a signal, wiped out, and rebuilt for a new signal thirty times a second!

Look carefully at the electron picture on the right side of this page. You will see that it is made up of dots, just as the mechanical television picture was.





THE SCANNING BEAM

At the other end of the Image Orthicon is a device called an electron gun. The electron gun sends out the stream of electrons just like a hose squirting water. The stream is called an "electron beam."

This beam goes back and forth across the target in an exactly timed order, just as the holes in the scanning disk looked at each part of the picture in order. The beam goes across 525 times before it reaches the bottom of the picture.

And it does this thirty times a second. Every single second 15,750 lines are "read" by the beam.

MAKING THE SIGNAL

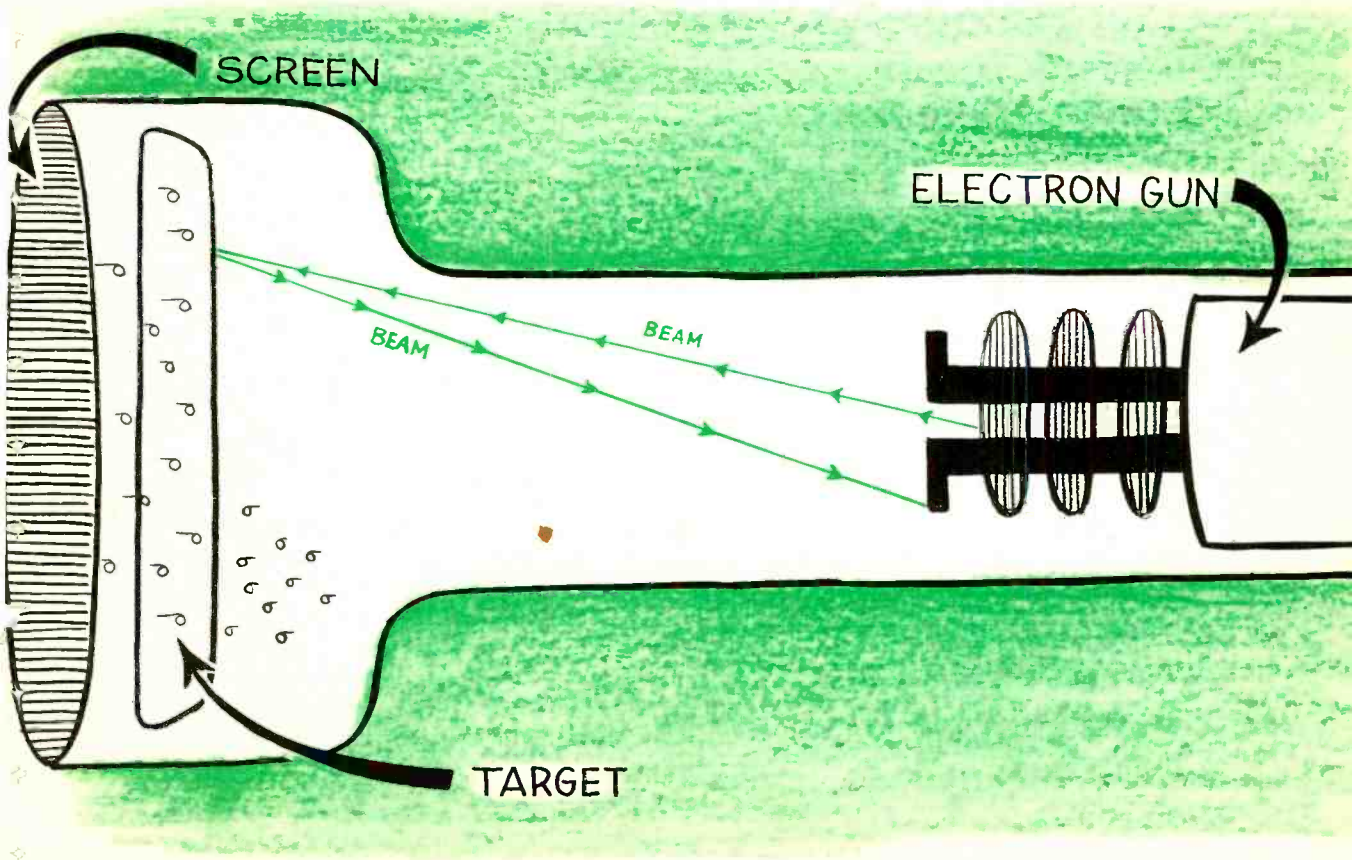
As the beam squirts against each part of the target, the electrons in it replace the electrons knocked out by the picture.

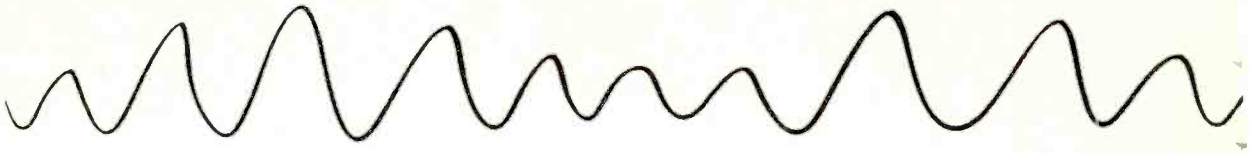
A white part of the picture made a lot of electron "holes" in the target. When the beam touches this part, the electrons in it are pulled into the holes. The beam is "eaten up."

A black part of the picture caused a few electrons to be knocked out of the target. A few electrons in the beam find holes in the target, but not all of them. Part of the beam is turned back from the target.

The parts of the beam that could not go into the target return to the other end of the tube beside the electron gun. These electrons go into a wire that leads them out of the tube.

These electrons make the picture signal.





HOW THE SIGNAL WORKS

The returned beam makes a current of big and little bunches of electricity that tell whether each part of the picture is white, black, or somewhere in between.

A white part of the picture made a spot on the target that took the electrons from the beam, so a white spot on the picture is signaled by a blank spot in the current.

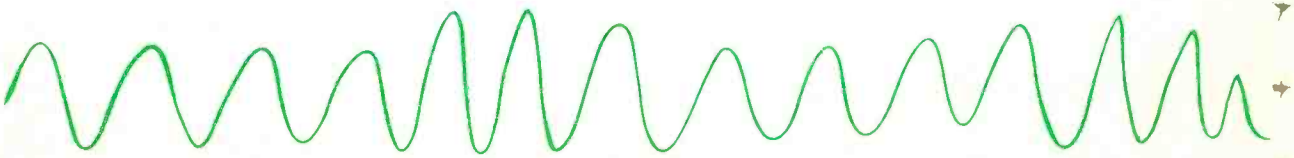
A black spot in the picture made no change in the target. All the beam was returned. A black spot is signaled by a strong part in the current, and a gray spot by a medium strong part of the current.

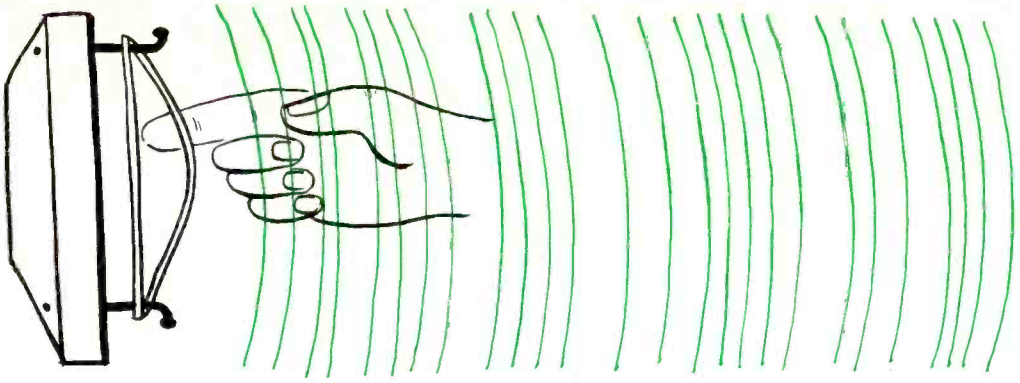
Now these signals are turned inside out so that your receiver can use them properly. This means that blank spots in the current are made strong, and strong spots are made blank.

SENDING THE PICTURE

The signal coming from the camera tube tells whether each part of the picture is light, dark, or somewhere in between. Now this signal must reach your receiver, so that you can sit at home and see the picture on your set.

First, the changes in the signal current are made stronger and stronger by going through several of the radio tubes described on pages 16, 18 and 19. Then this much stronger signal is carried by radio waves to your receiver.





Radio waves are something nobody knows a great deal about. We know they are vibrations, but we do not know what it is that is vibrating. Radio waves do not seem to need anything to travel on. They can go through empty space—even through a vacuum.

Except for the fact that they can go through a vacuum, radio waves seem to be very much like sound waves. You know that a sound is just a vibration in the air. If you stretch a rubber band tight and pluck it, it makes a sound because it keeps making ripples in the air as it moves back and forth. These ripples spread out and hit your eardrums.

Radio waves are ripples, too, but they travel much faster than sound waves. They travel just as fast as light, 186,000 miles a second.

Radio waves vibrate much faster than sound waves, too. You can hear sounds that move back and forth from around ten times a second to around 15,000 or 20,000 times a second.

Radio waves used for television move back and forth from 44 million to 88 million times a second. New "ultra high frequency" television waves vibrate 174 to 216 million times a second.

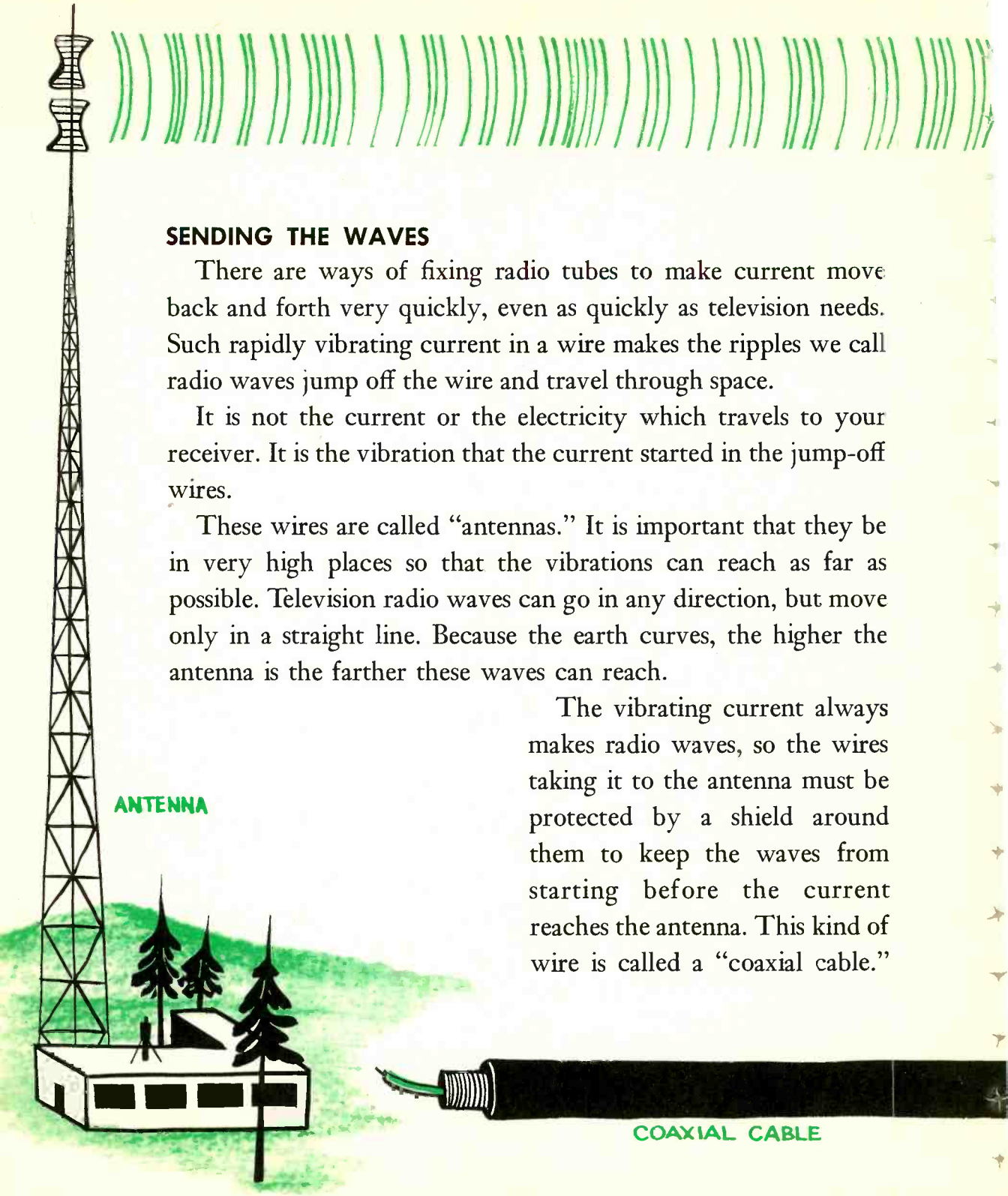
SENDING THE WAVES

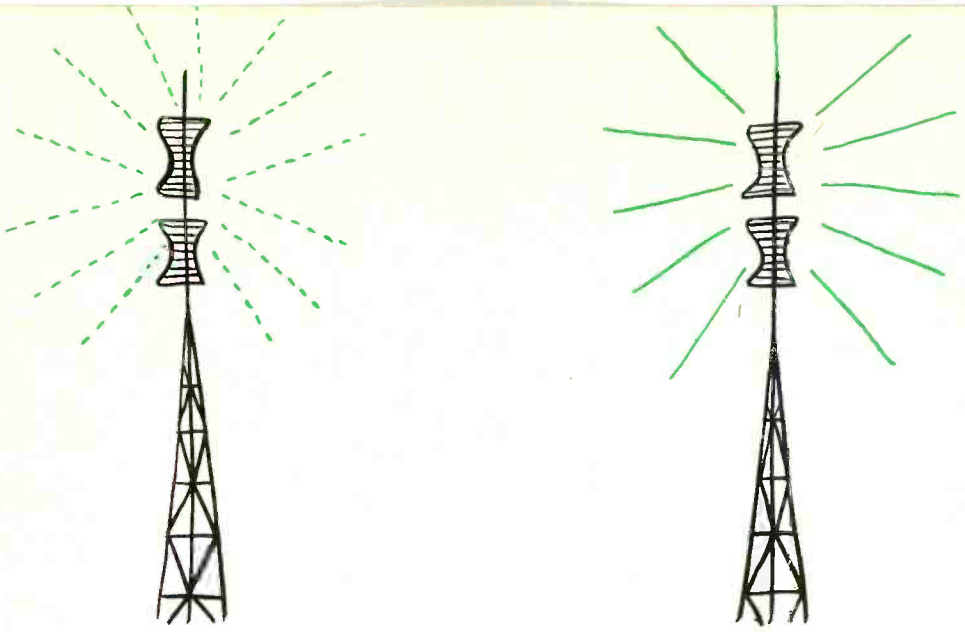
There are ways of fixing radio tubes to make current move back and forth very quickly, even as quickly as television needs. Such rapidly vibrating current in a wire makes the ripples we call radio waves jump off the wire and travel through space.

It is not the current or the electricity which travels to your receiver. It is the vibration that the current started in the jump-off wires.

These wires are called "antennas." It is important that they be in very high places so that the vibrations can reach as far as possible. Television radio waves can go in any direction, but move only in a straight line. Because the earth curves, the higher the antenna is the farther these waves can reach.

The vibrating current always makes radio waves, so the wires taking it to the antenna must be protected by a shield around them to keep the waves from starting before the current reaches the antenna. This kind of wire is called a "coaxial cable."





HOW THE SIGNAL RIDES

There are two kinds of vibrating electric current. One is the current that brings the picture signal from the camera. It is moving in little spurts. Each spurt means a bright part of the picture. The other kind is the current that will make the radio waves. It is moving back and forth from 44 to 88 million times a second.

The picture from the camera tube controls the amount of radio wave current that reaches the antenna. When a spurt comes to signal a bright spot in the picture, a lot of current goes into the antenna. A very strong radio wave goes out. When a dark spot is signaled by a weak place in the current, a much weaker radio wave goes out.

Now, when the receiver gets the radio waves, it can tell what the picture signal is by the strength of the radio waves.

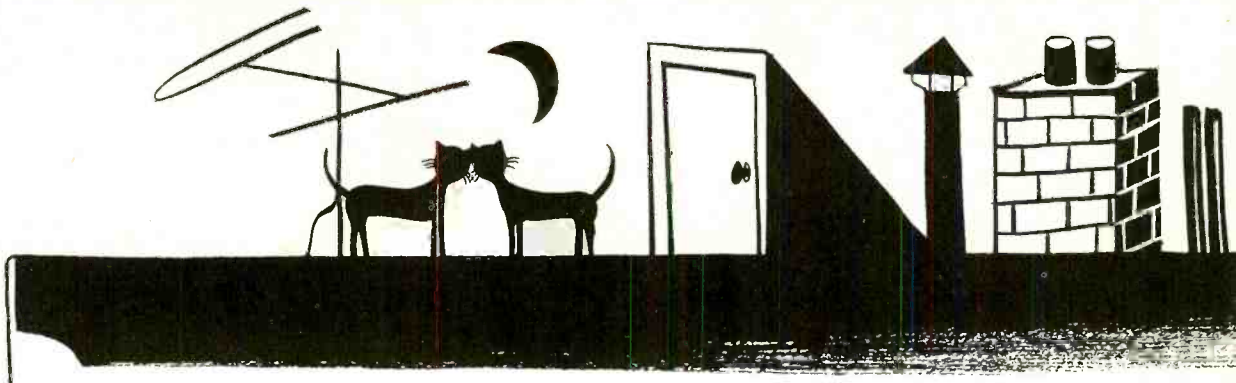
YOUR RECEIVING SET

The radio waves sent out by the antenna go everywhere. They go right through houses and trees and even people. But you can't feel them.

Whenever the radio waves hit a wire, they start electricity moving in it. The current is very weak because the radio waves are very weak.

Your television set is connected to a special kind of wire designed to use these radio waves as efficiently as possible. This wire is also called an antenna. You can see antennas on the roofs of many houses. Closer to the broadcast stations, smaller indoor antennas can be used.

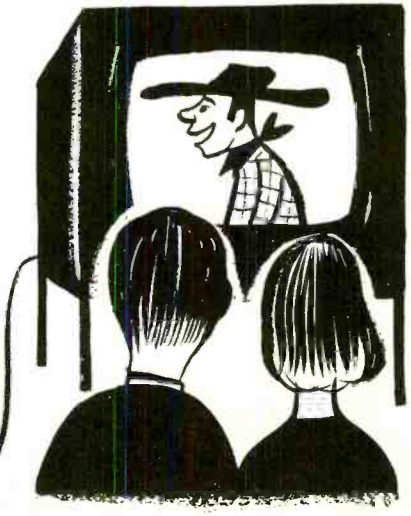
Your antenna is connected to your set. The electricity comes down from your antenna into your set.

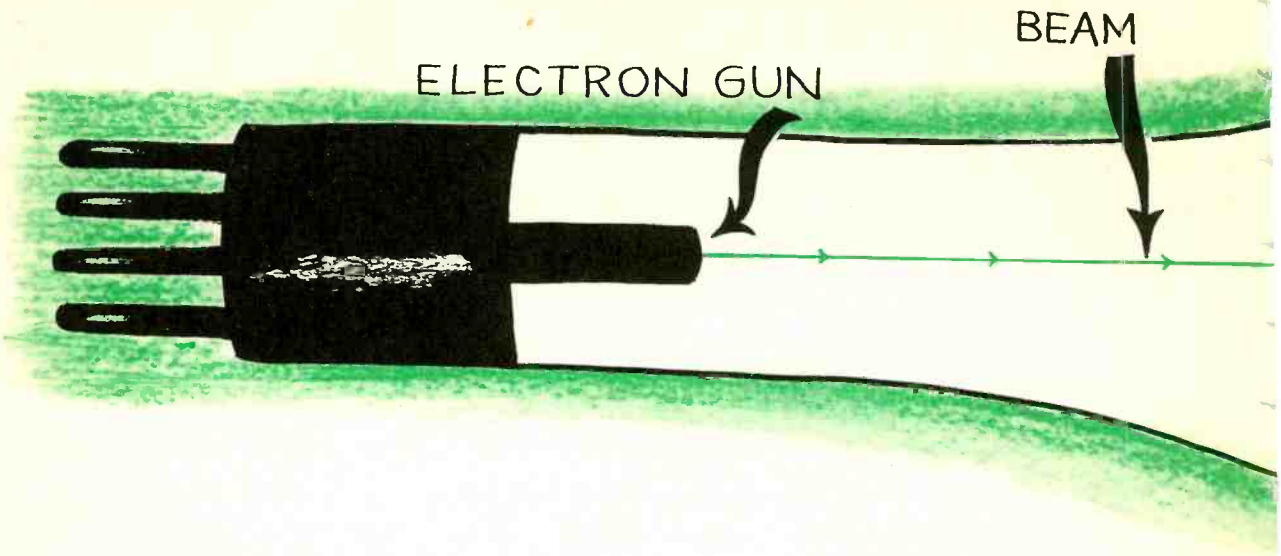


Now your receiver does two things. First, it picks out just one of the many radio signals. All the radio waves start electricity moving in your antenna, but there is a device in your set that picks out just one of them. It does this by "tuning" to the frequency of the signal you want, just as you can pick out a certain note on a slide trombone by tuning the slide to the note you want. You control your television frequency with the channel dial.

Then the signal you have chosen is put through several vacuum tubes to make it stronger. The very quick vibrations of the radio wave that carried it are cut away so that you have only the picture signal left. The signal then goes through still more radio tubes to make it stronger and stronger.

Now you have, inside your receiving set, the exact same spurts of electricity that came out of the Image Orthicon camera tube — except that they are turned inside out so that a strong spurt means a white spot and a blank space means a black spot.





THE PICTURE TUBE

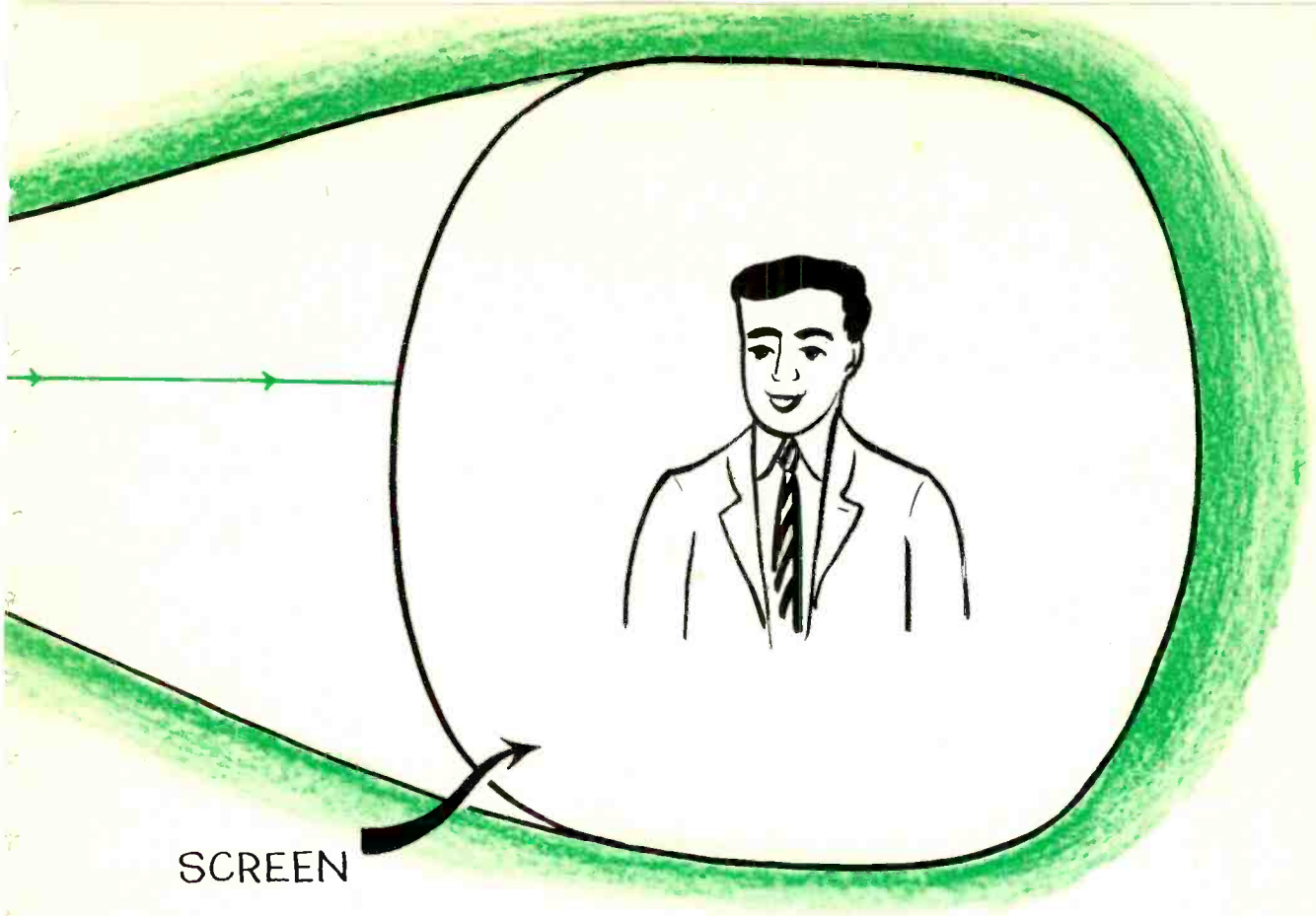
Inside your set is a big vacuum tube called a "kinescope." "Kine" means "motion" and "scope" means "tube." The word means "motion tube."

One end of this tube is the screen of your television set.

At the other end of the tube is an electron gun, very much like the electron gun in the Image Orthicon. It shoots a stream of electrons at the big picture end of the tube.

The picture signal is used to control the strength of the electron beam shooting against the screen of the picture tube. When there is a strong signal for a white spot, there are a lot of electrons in the beam. When there is a weak signal for a dark spot, there are very few electrons in the beam.

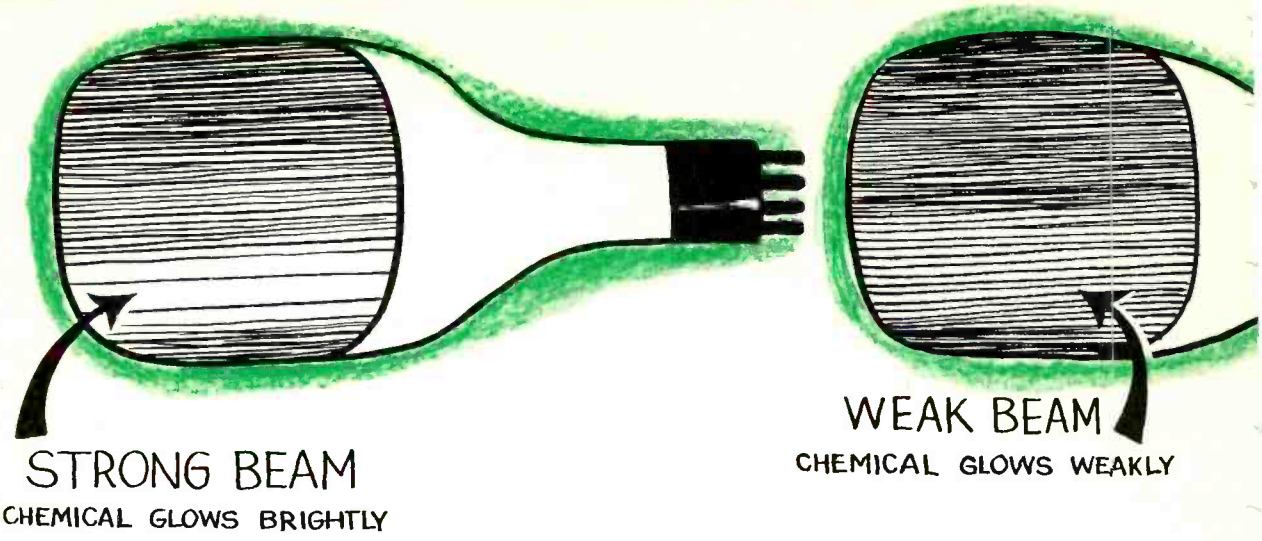
When each spurt of picture signal reaches your set, the beam in your picture tube must be in exactly the same position as the scanning beam in the camera tube was.



This means that if the scanning beam in the camera tube was making a signal for the upper right-hand corner of the picture, the beam in your picture tube must hit the upper right-hand corner of the screen at the exact moment when the signal reaches your set.

This is arranged by having another signal ride the radio wave to your set—a signal that controls the bending of the electron beam in your picture tube.

And of course, the sound that goes with the picture is also riding the same radio wave.



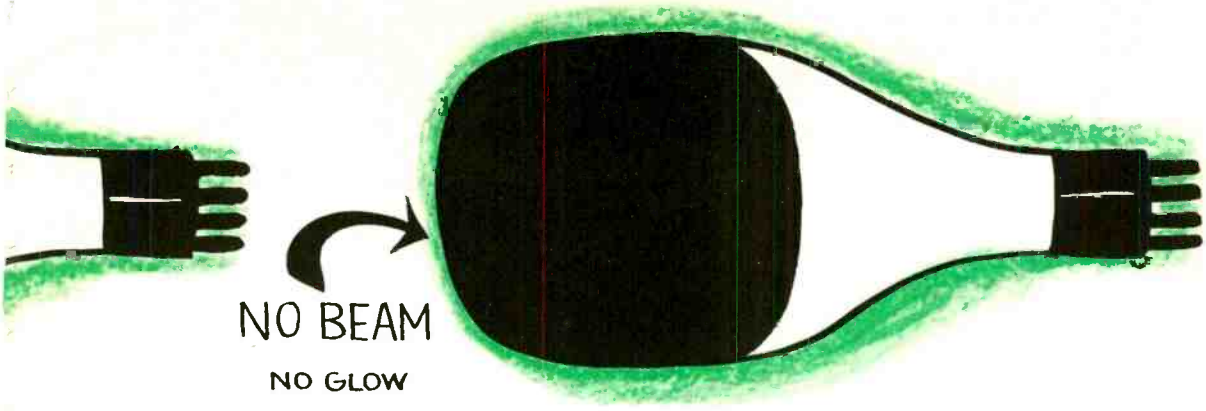
THE PICTURE SCREEN

The screen end of the kinescope is coated with a fluorescent chemical. "Fluorescent" means "glowing." This chemical glows when electricity hits it. When no electricity hits it, the screen stays dark.

Now you see how your picture tube works. When the camera tube sends a strong signal to tell about a white spot, this signal makes the electron beam in your picture tube strong. The strong beam makes the exact same spot of your screen glow brightly.

When the camera tube sends out a weak signal because a certain part of the picture is dark, the electron beam in your picture tube is weak. Little electricity hits the screen. The chemical on that part of the screen is dark.

And all of this is going on at the rate of 525 lines thirty complete times every second.



CONTROLS ON YOUR SET

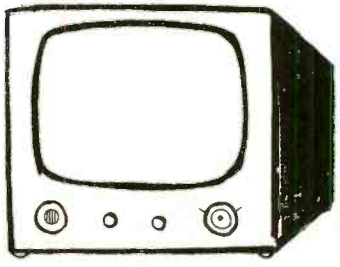
There are many controls on your receiving set. Different brands have different names for them, and even different numbers of controls. Some sets are more automatic than others and have few controls you can see. The others are inside, where only a repair man can get at them.

There is an "off-on" control. This connects your set to your house electricity, so that all the parts can have the power they need to work.

You may have noticed that it takes a little while for anything to happen after you turn your set on. This is because none of the vacuum tubes can begin working until the hot wires that kick off electrons get hot enough to work. It takes a little time for them to warm up.

There is a "tuning" or "channel selector" knob. This picks out the right signal from the station you want by "tuning" to it.

The "volume" control makes the sound louder or softer by changing the strength of the signal going into the vacuum tubes.




HORIZONTAL HOLD


VERTICAL HOLD

SOUND

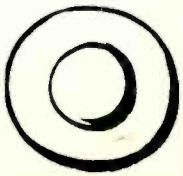
The "brightness" control changes the amount by which the picture signal is made stronger by the radio tubes. If the signal is too strong, there is more difference between the light and dark parts of the picture than the camera meant to show. The picture does not look real. If there is too little contrast, you can hardly see the picture at all.

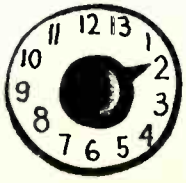
You may also see controls for "magnification" or "size," "vertical hold," and "horizontal hold" on your set. Different sets have different controls for these, and some of them are inside.

The magnification controls change the amount the beam goes up and down and from side to side. They must be adjusted so that the picture is just the size of the picture tube screen. If the picture is too big, part of it is outside the edges of the screen and you can't see all of it. If the picture is too small, it is too little to see clearly.

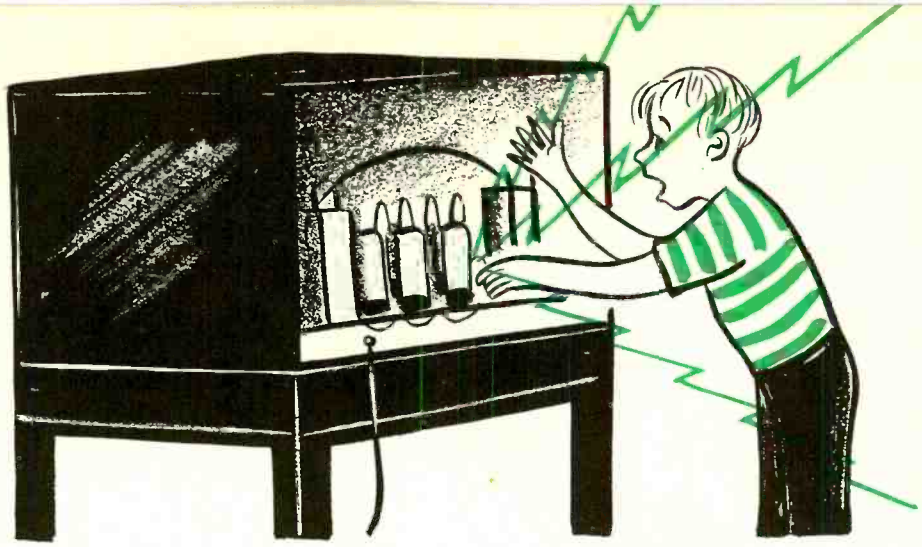
The hold controls adjust the timing of the up-and-down and back-and-forth sweeps of the beam. The beam must be in exactly the right place at the right time or else the picture will not look right.

Perhaps you have seen the picture on your set climb right off the top of the screen while another picture chases it up from the bottom, over and over. This means that the up-and-down timing of the beam is just a little wrong. The hold control will change the timing and fix this.


BRIGHTNESS, CONTRAST

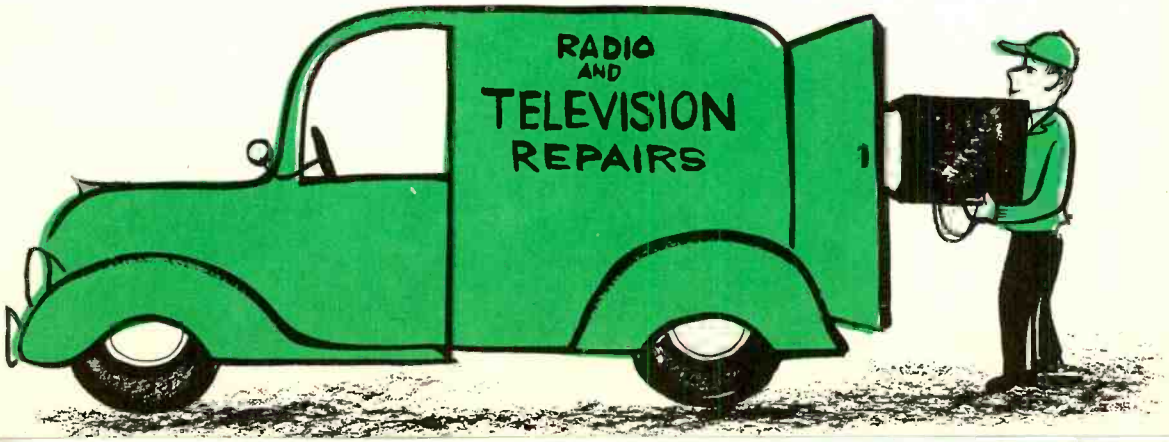


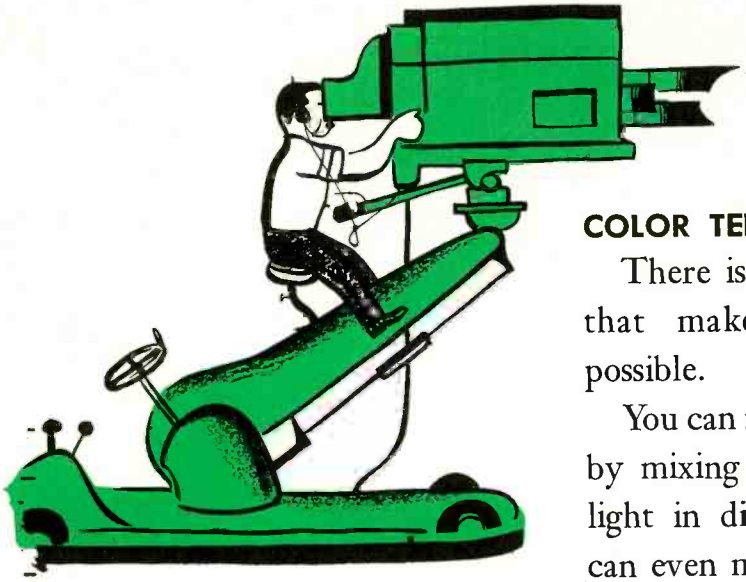
CHANEL SELECTOR



Although you know how your television set works, you must be sure not to try fixing it yourself. Never put your fingers or any kind of tool inside it. Television works with very high voltages —electron pressures. You can be very badly hurt if you happen to touch the wrong part. It is not even safe with the set turned off or unplugged, because the set stores these pressures for some time. It can still hurt you.

So leave repairing or adjusting your set up to a repair man. Stand by and watch if you want to, but don't try to work on it yourself.





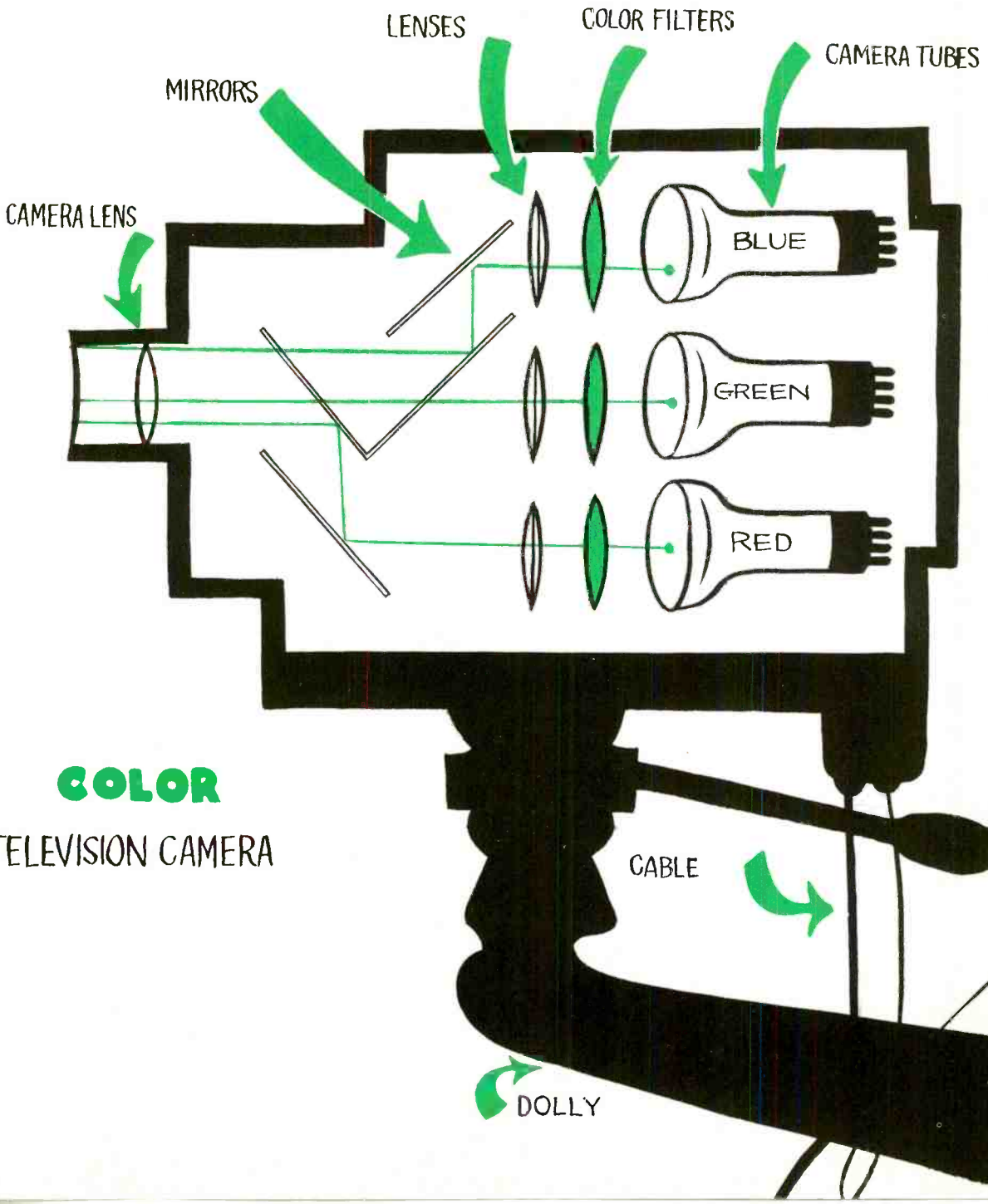
COLOR TELEVISION

There is a very special secret that makes color television possible.

You can make almost any color by mixing red, blue, and green light in different amounts. You can even make white by mixing all three! Red and blue light will mix to make purple. Red and green light will mix to make yellow. No light at all will give black.

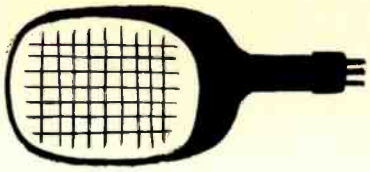
Modern color television sends three picture signals instead of just one. One signal is for the red part of the picture. One is for the blue part. One is for the green part.

The three signals come from three camera tubes. Each tube looks through a colored window that shows only the part of the picture in that color. One tube sees only the red part of the picture — not only red things, but the amount of red in things of other colors. The red-seeing tube would send a strong signal for a red color and a weak signal for a yellow color, and no signal at all for a blue color. One tube sees only the blue parts, and one the green parts.



COLOR

TELEVISION CAMERA



All three signals ride the same radio wave to your receiver, all at the same time.

Now you must have a very complicated receiver to separate these color signals. Your regular set, though, will pick them up and show them as an ordinary black-and-white picture. The color receiver must separate the three signals and send each of them to a different electron gun. All three electron guns are in one big picture tube.

THE COLOR TUBE

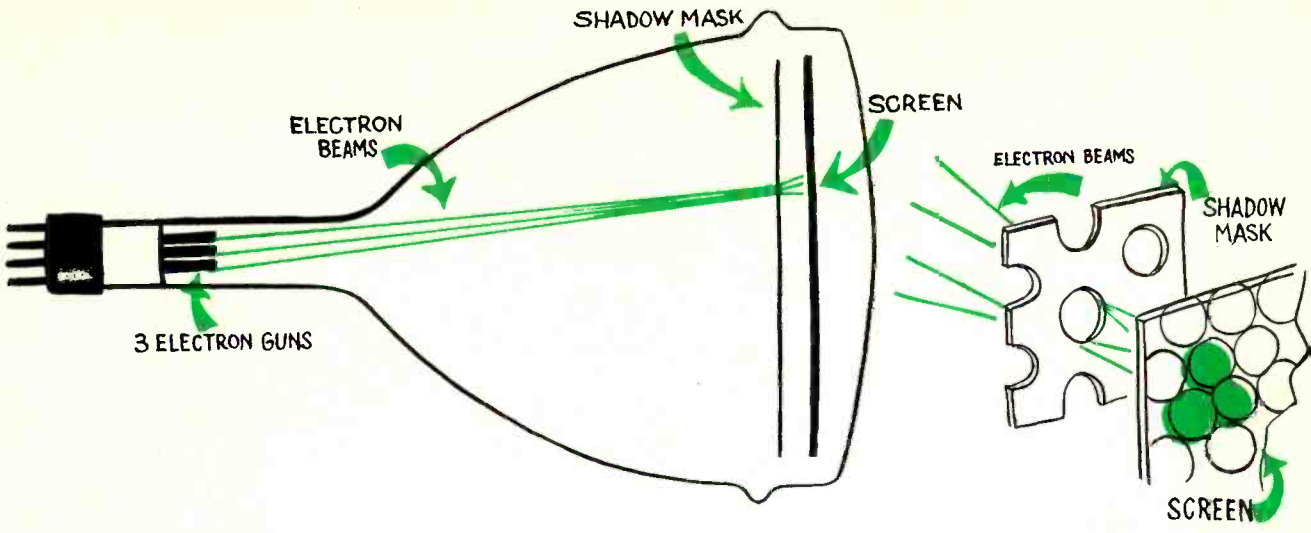
The screen of this color picture tube is different from the one in a black-and-white picture tube. There are three different kinds of fluorescent chemical on it.

One glows red when electricity hits it. Another kind glows blue. The third kind glows green.

Tiny dots of these chemicals are arranged in little groups of three all over the screen. Each group has a dot of each kind of chemical—red, blue, and green.

There are 250,000 of these groups on the screen—750,000 chemical dots in all!

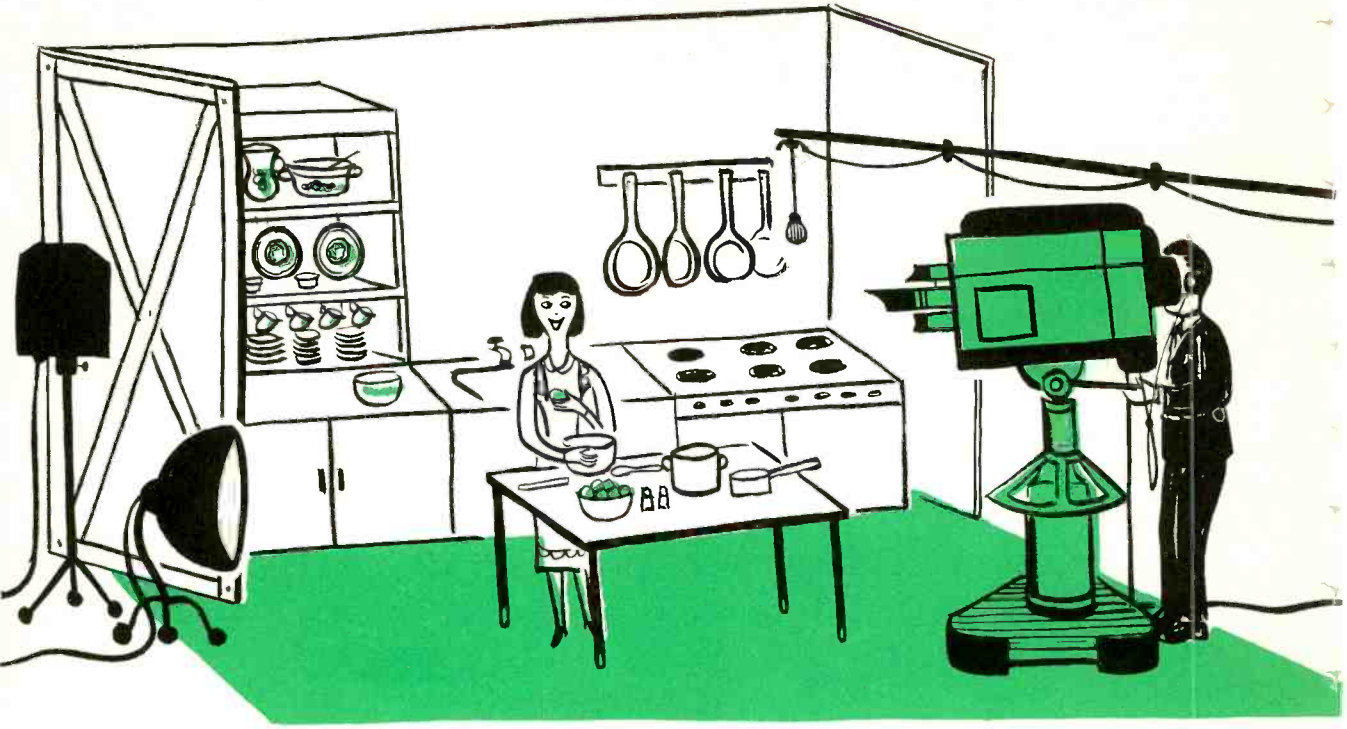
Between the screen and the three electron guns is a "shadow mask." This is a piece of metal with very tiny holes in it. There are 250,000 holes, one for each group of three chemical dots on the screen.



The three electron guns are in slightly different places. The shadow mask is carefully placed so that the holes line up with each gun and the dots of chemical that glow in the right color for the signal from that gun.

One electron gun sends out a beam with the signal for only the red parts of the picture. Because of the shadow mask, the electron beam from this gun can touch only the dots of chemical that glow red. The mask shuts off the beam from hitting any of the blue or green dots. The same holes let the beam from the blue-signal electron gun hit only the blue-glowing dots. And the beam from the green-signal electron gun can hit only the green-glowing dots.

Because all these dots are so close together, your eyes blend the red, blue, and green dots into a colored picture. They are fooled about color just as they are fooled about motion. And you seem to see real color television.

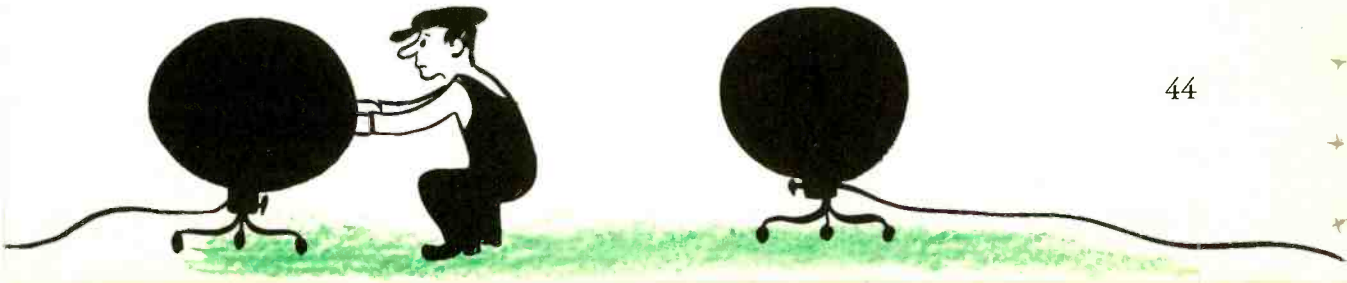


HOW PROGRAMS ARE MADE

There are many different types of television programs.

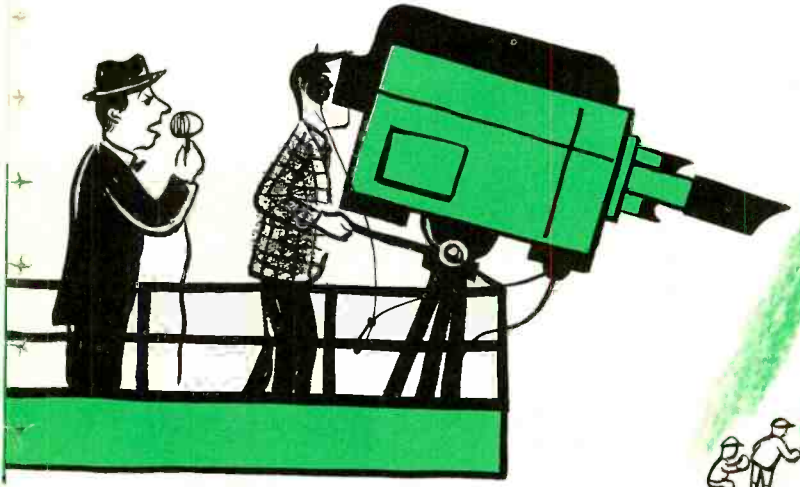
Some of them are plays, quiz programs, variety shows, puppet plays, and other kinds in which live actors are performing at the same time that the program is broadcast.

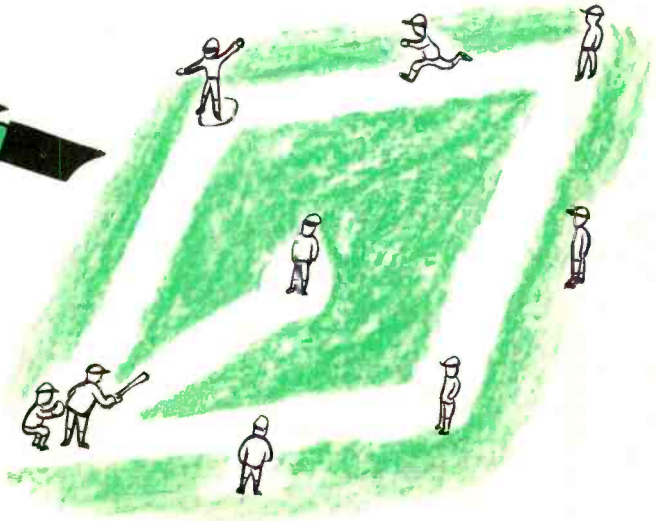
Some programs are made ahead of time and kept on movie film. When you see the program on your set, you are really seeing a broadcast of the movie. Motion pictures and cartoon advertisements are of this type.



Other kinds of programs are televised—which means photographed by a camera tube—outside the studios. Cameras are set up at football and baseball games so that you can watch them at home right while the games are going on. Important speeches are televised wherever the speaker is. The signals from the cameras are sent back to the main broadcasting studios through coaxial cables or by special radio waves just strong enough to reach the studios.

This kind of program is called a "remote," because the action being televised is remote – which means far away – from the studios.



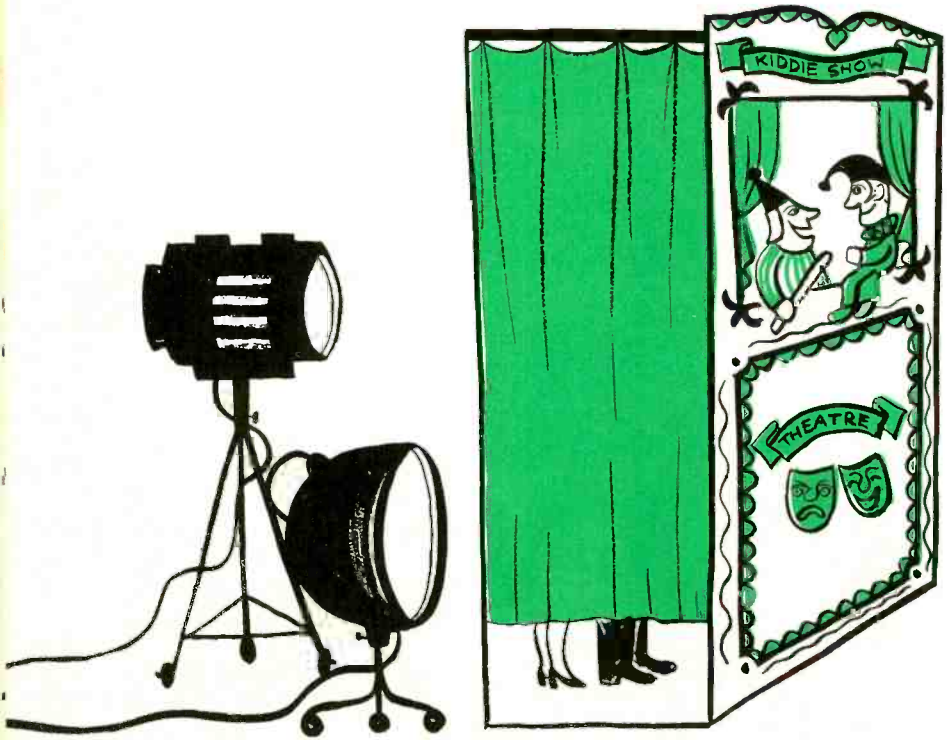


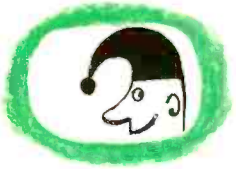
THE CAMERAS

You may have noticed that on television you never watch the actors from one place for very long. It is as if you were always walking around and looking at them from different angles. These changes of place often happen suddenly, as if you had jumped somewhere else in no time at all.

One minute you seem to be standing clear across the room from the actors. The next minute, you are so close you can see only their heads. A moment later, you are suddenly on the other side of them.

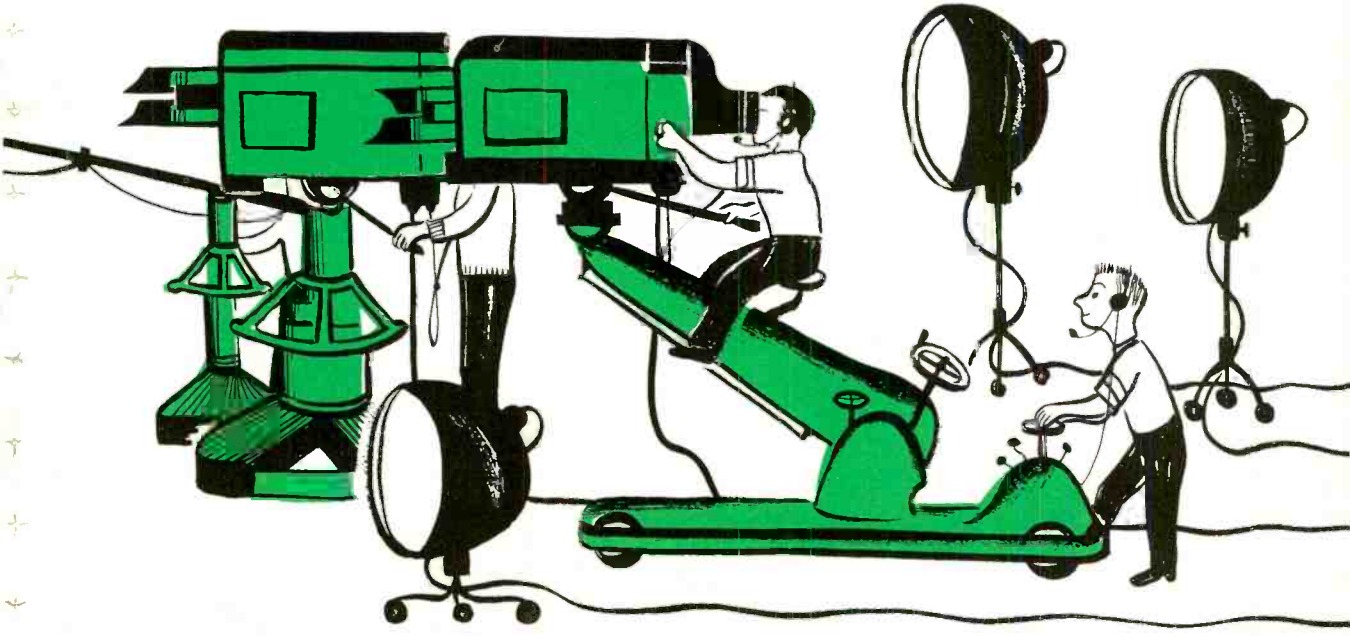
This is done through the use of two cameras.





Each camera has a camera tube inside. Usually it is an Image Orthicon. The camera is on a heavy cart with rubber wheels so that it can move around silently and smoothly. The cameraman looks into a little window where he sees the picture being taken by the camera tube. He has controls for raising or lowering the camera, moving it backward or forward, and turning it from side to side. He wears earphones so that the director can give him instructions about how to move the camera.

Both cameras are taking pictures all the time. The electric signals for the pictures from both cameras are sent through wires to the control room. When the scene changes or you suddenly jump to a closeup, the signal from the other camera has been connected.



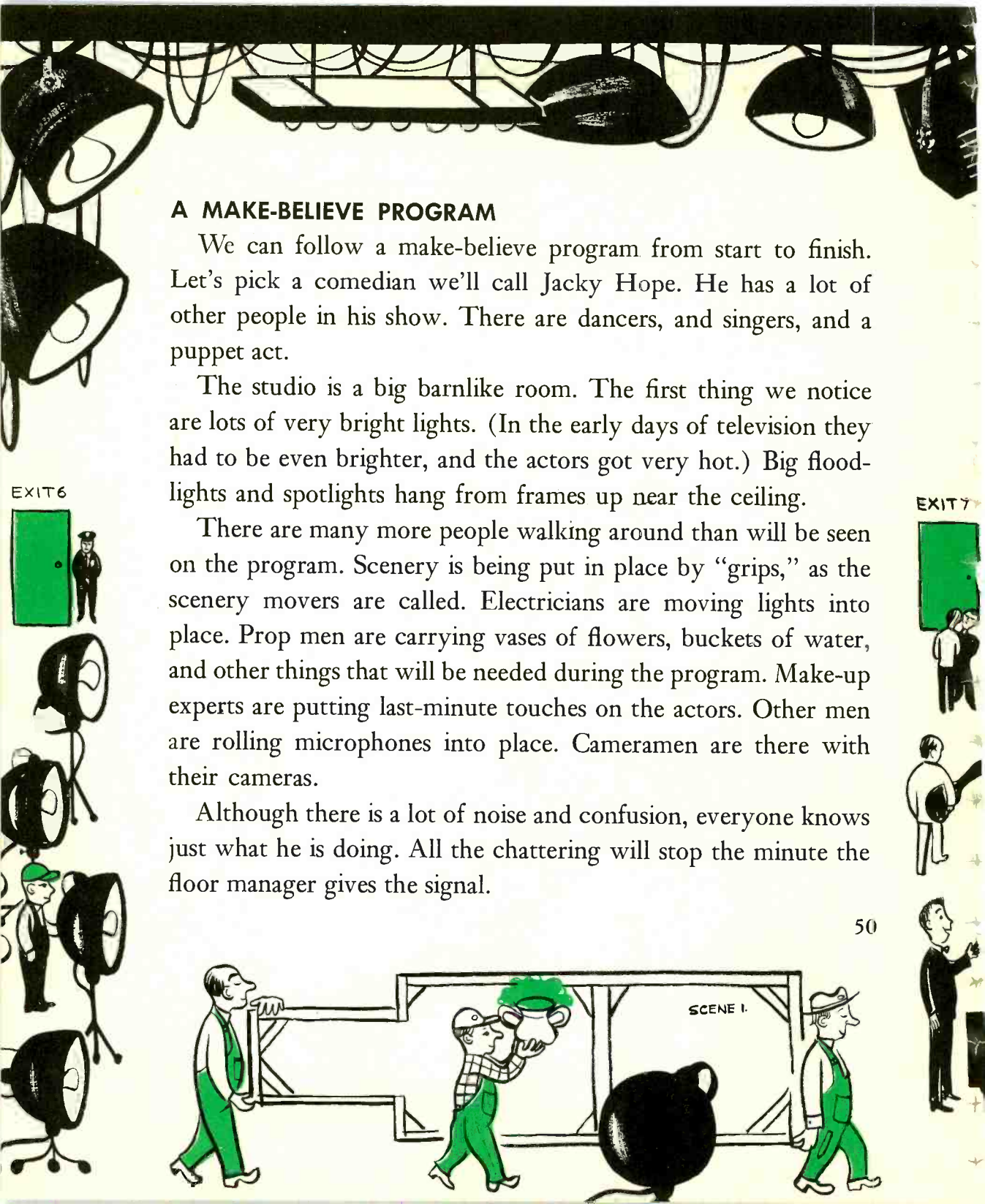
A MAKE-BELIEVE PROGRAM

We can follow a make-believe program from start to finish. Let's pick a comedian we'll call Jacky Hope. He has a lot of other people in his show. There are dancers, and singers, and a puppet act.

The studio is a big barnlike room. The first thing we notice are lots of very bright lights. (In the early days of television they had to be even brighter, and the actors got very hot.) Big floodlights and spotlights hang from frames up near the ceiling.

There are many more people walking around than will be seen on the program. Scenery is being put in place by "grips," as the scenery movers are called. Electricians are moving lights into place. Prop men are carrying vases of flowers, buckets of water, and other things that will be needed during the program. Make-up experts are putting last-minute touches on the actors. Other men are rolling microphones into place. Cameramen are there with their cameras.

Although there is a lot of noise and confusion, everyone knows just what he is doing. All the chattering will stop the minute the floor manager gives the signal.



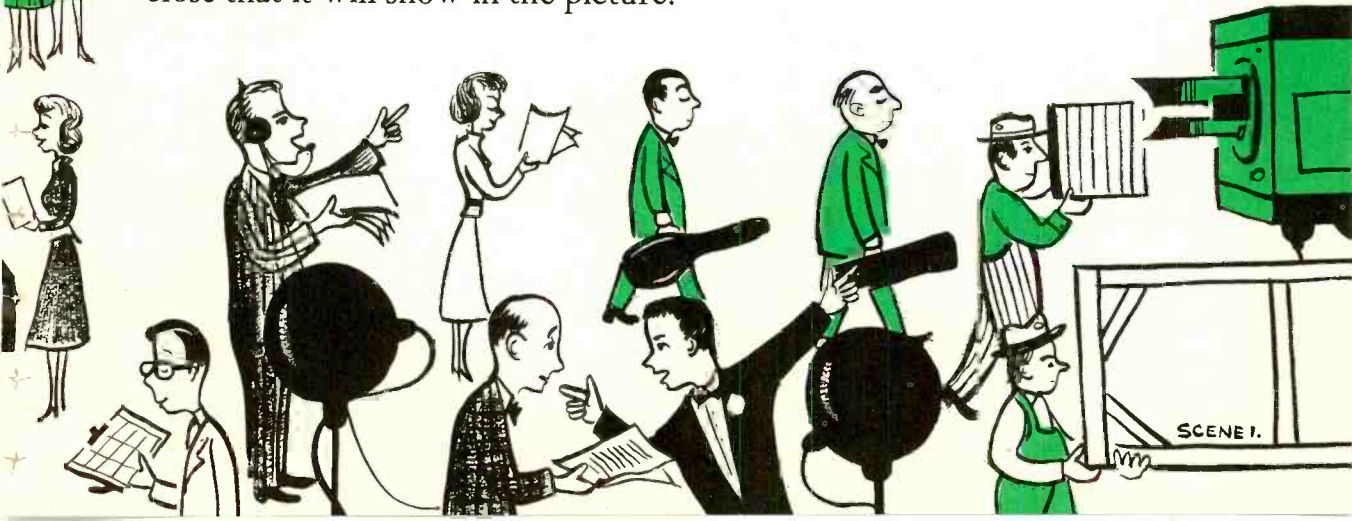
The floor manager is in charge in the studio. He wears earphones and has a little microphone through which he can talk to the director. He makes sure that each scene is ready when it should be, with the actors in place, microphones and cameras where they should be, and all the other details taken care of.

"Thirty seconds," calls the floor manager.

This means that the program is scheduled to go on the air in half a minute.

The "grips" make final adjustments to the scenery. For the first scene, this is a living-room wall with a couch, lamps, and table in front of it. The wall looks real, but it is really only painted canvas on a very light frame. The paint can be washed off and other colors painted on very easily, and the whole thing is so light that it can be easily moved around and stored.

The microphone men get the microphone into the right position. It hangs at the end of a long boom so that it will be right over the actors' heads. It must be as close as possible, but not so close that it will show in the picture.



One cameraman rolls his camera up close. He twists a frame on the front that puts a close-up lens into place. The other cameraman takes his position a little farther away. He turns the medium-length lens into position. Every time a camera moves very much closer or farther away, the lenses must be changed.

Jacky Hope sits on the couch with another actor beside him. The lights are adjusted just right.

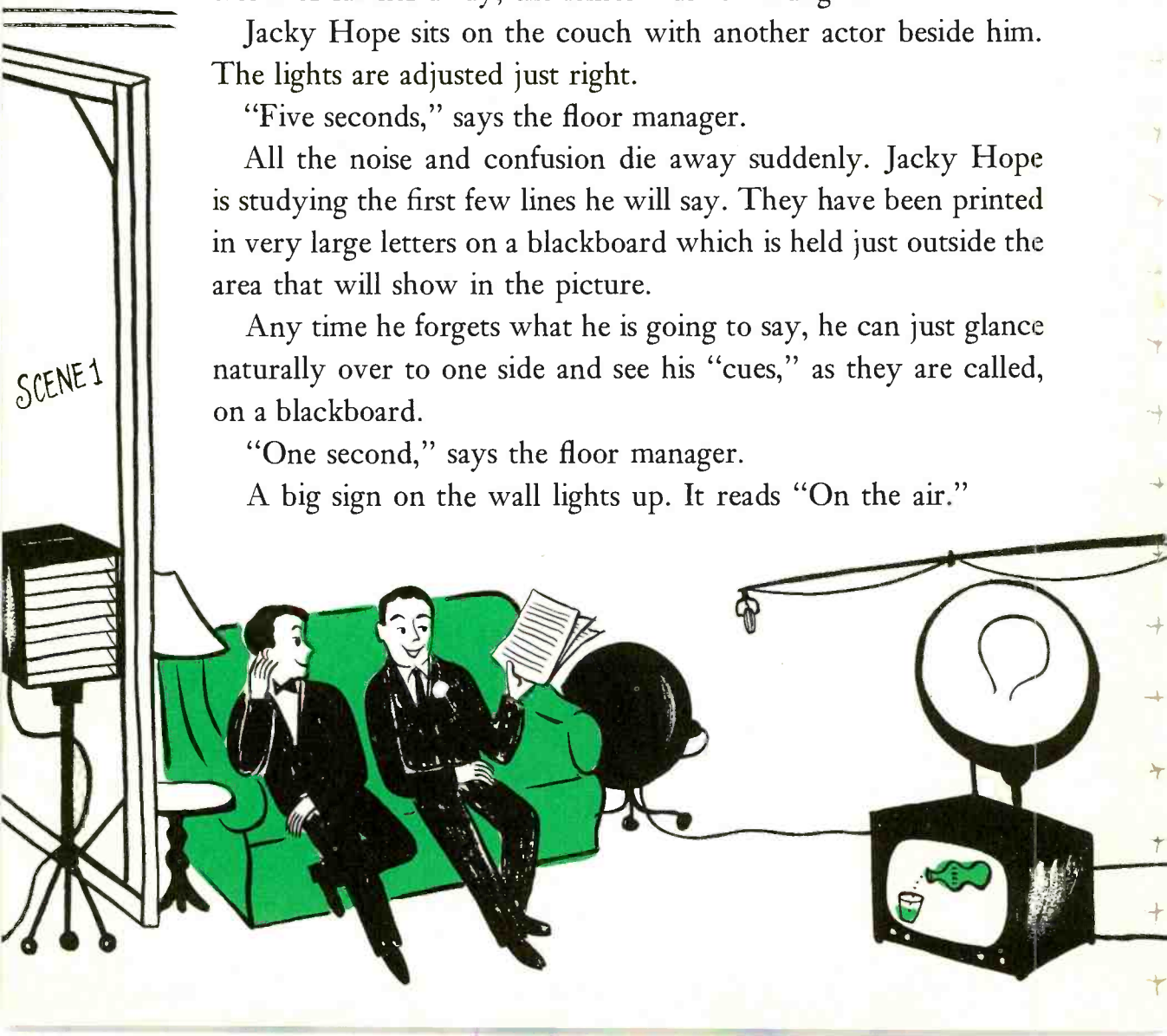
"Five seconds," says the floor manager.

All the noise and confusion die away suddenly. Jacky Hope is studying the first few lines he will say. They have been printed in very large letters on a blackboard which is held just outside the area that will show in the picture.

Any time he forgets what he is going to say, he can just glance naturally over to one side and see his "cues," as they are called, on a blackboard.

"One second," says the floor manager.

A big sign on the wall lights up. It reads "On the air."



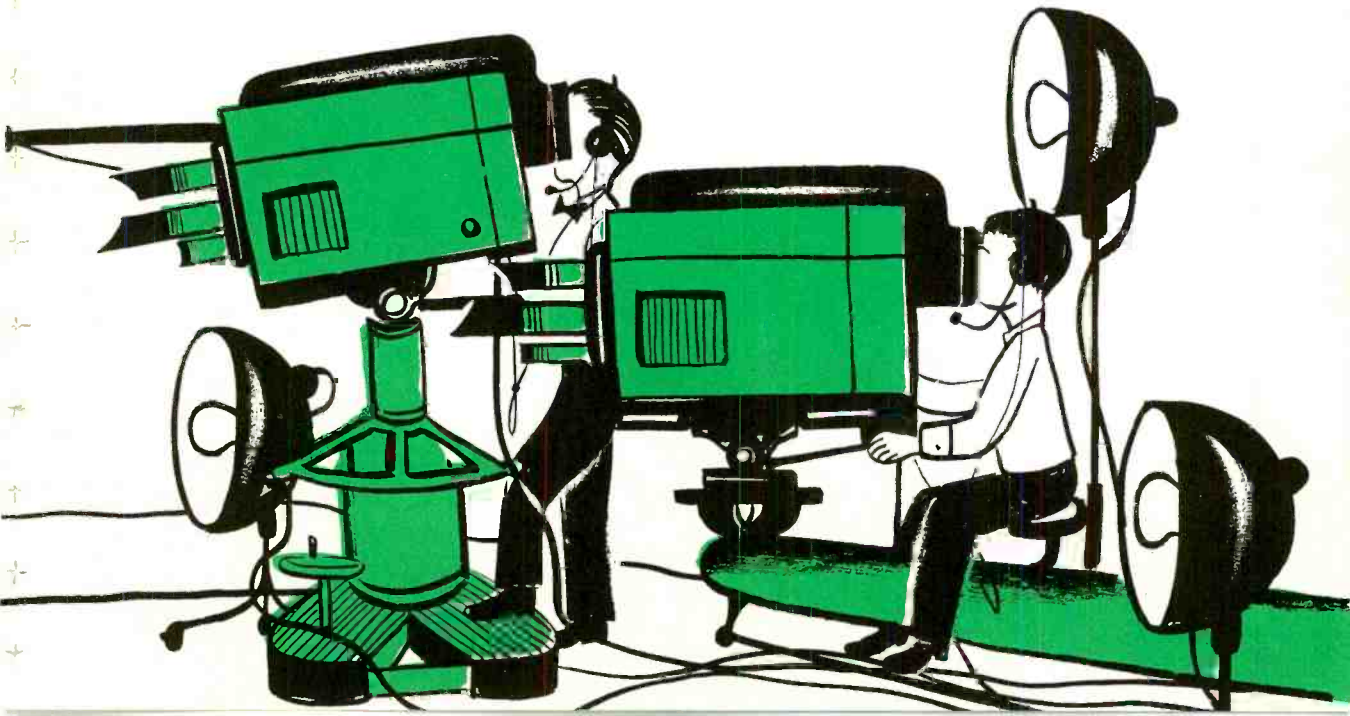
ON THE AIR

But Jacky Hope doesn't say anything yet. There is a small television set facing him. On the screen he sees a bottle of soda pop being poured into a glass. A loud-speaker is saying: "And now for our weekly frolic with Jacky Hope, brought to you by Snappi-Cola."

The picture of the bottle being poured into the glass is on movie film, which is being run off in another studio. An announcer off to one side is reading the opening speech into a microphone.

Jacky Hope knows that he is to begin as soon as the "commercial," as it is called, ends. And he also knows that the last words of the commercial will be "drink Snappi-Cola tonight." So as soon as he hears these words, he takes a deep breath and waits until he sees his own picture on the screen.

Then he begins the program.



THE SPONSOR

The company that makes Snappi-Cola is paying for the air time for the Jacky Hope show. This means that it is paying all the costs of running the studio, the broadcasting station, all the people who are working there during that time, and also those same expenses of any other stations in other cities that are broadcasting the show. It is also paying Jacky Hope his salary, and the expenses of all the other actors, "grips," electricians, and the many other people who are needed to put the show on.

This is why you don't pay anything to see an expensive show on television. The way you pay is to listen to the "sponsor," as he is called, tell you about what he makes and why you should buy it.

THE CONTROL ROOM

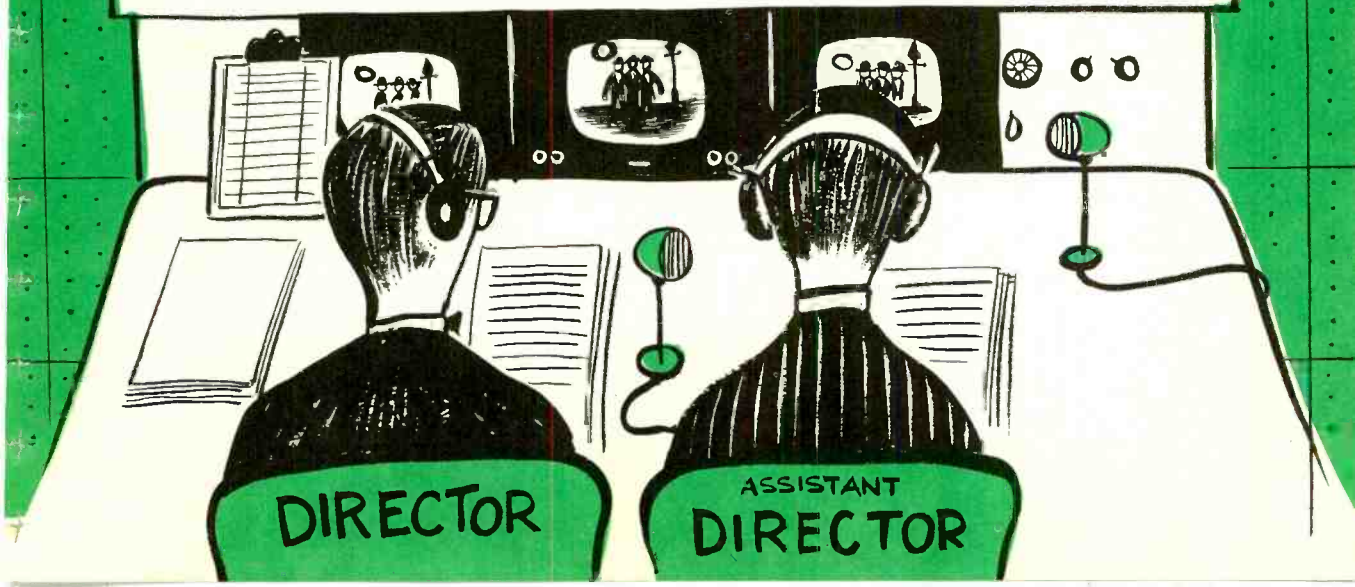
Right next to the studio is the control room. The wall between is made of glass, so that the people in the control room can see everything that happens in the studio.

The man who is in charge of the program sits in the control room. He is called the director. He wears earphones and has a microphone through which he can talk to the floor manager and cameramen in the studio without being heard on the air.

The director is the one who decides which camera will "take" each scene, and from what angle. When he wants to change to another camera, he first warns the man running it. He tells him where to go and how to point the camera. Then he pushes a button that changes cameras.

Beside the director is an assistant director who has a "script." This is the story of the program, with everything to be said and done written down. On the margins of the script are notes that tell when a commercial will run, when the scene will change, when sound effects are needed, and so on.

The assistant director warns the director a little while before any change will be needed. Then the director has time to get things ready and warn the cameramen of the change.



THE ENGINEERS

Besides watching the studio through the glass wall, the people in the control room also watch the pictures the cameras are taking. There is a television screen for each camera that always shows what that camera is doing. Above these screens is a master screen that shows the picture being sent out over the air.

In front of the screens sit people called television engineers. They are in charge of the technical quality of the pictures—how bright they are, how clear, how even, and how well centered. They are busy adjusting controls that keep the pictures good and clear.

Another person in the control room is in charge of the sound. He has a number of switches that turn on different microphones. When a commercial goes on, for instance, he must do several things. He must turn on the microphone for the announcer and see that the sound is just loud enough. He must turn off the microphone that was being used before so that no unwanted sounds of people moving around will be broadcast.

If there is a musical background for the commercial, he must start a record player with the music and turn on another switch that will feed the music into the wires that are also carrying the announcer's voice.

CHANGING SCENES

The first part of the Jacky Hope program is almost over now. Next there will be a puppet act.

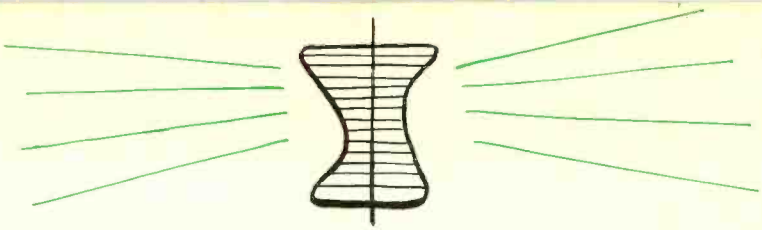
The assistant director has told the director that the puppet act will come in one minute. He speaks into his microphone and asks one of the cameras to get ready, and tells the floor manager that the puppets will go on in one minute.

The cameraman wheels his camera over to another set right next to the one being used now. The director watches the screen that shows the picture this camera is taking, and tells him to make little changes to give a better angle.

Meanwhile, the floor manager has told the puppeteers to get ready. They get behind the stage and put the puppets on their hands.

When the first part of the program is over, the director pushes the button that changes to the camera already taking the puppets. They start their act. The other camera is now off the air, and is wheeled over to the puppet stage so that changes of angle can be used here too.

The "grips" are already tearing down the living-room scene used for the first act. They pull on ropes that carry the living-room wall up to the ceiling. Another scene, painted like a garden, is lowered into place. The couches and tables are carried away



and artificial bushes put into place. Jacky Hope is busy changing his clothes behind a screen.

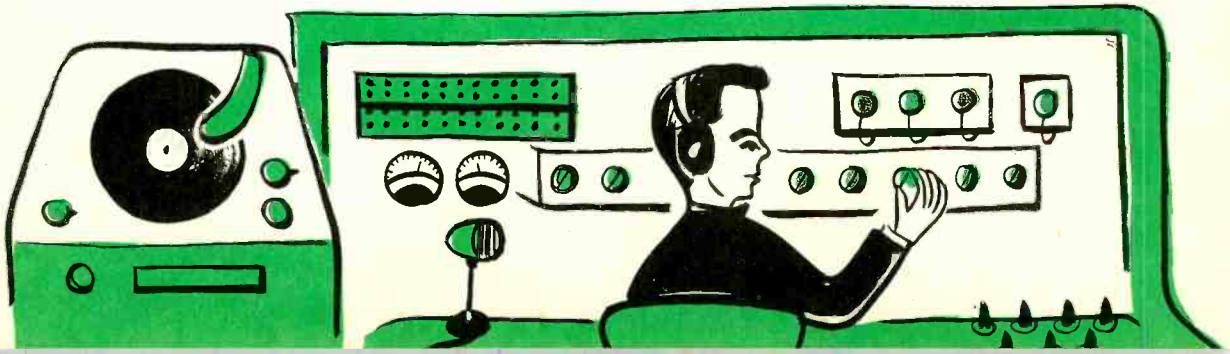
By the time the puppet show is over, Jacky Hope will be ready in the new scene. One of the cameras will come over a little ahead of time to get ready, so that the acts can change at once.

Although everything seems confusing, all these people have been doing this long enough so that on the air the changes are smooth and take place in the twinkling of an eye!

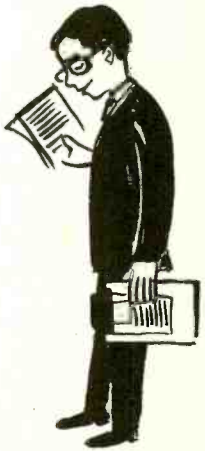
MASTER CONTROL

From the studio control room, the signals for the Jacky Hope show go to master control. This is the "brain" of the whole station, or even the whole network. While one program is being broadcast, another group of cameras may be getting ready to televise a speech or a game somewhere outside the studios. After that, another program from another studio may be scheduled.

Master control keeps in touch with all these people. It makes sure they know when they are to go on the air. It tests to see if the signals are coming in properly from the cameras before the programs start. It makes many final adjustments to the signals. And it changes over to the proper set of cameras when the program changes.



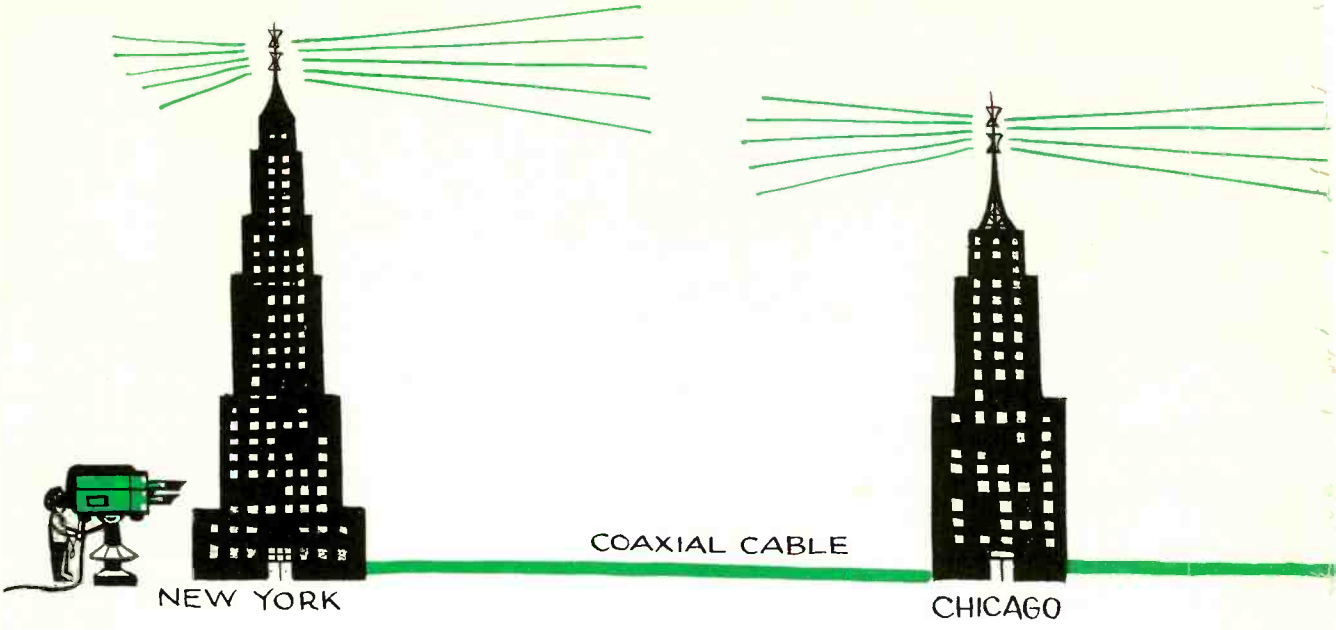
THE TRANSMITTER



From the master control room, the signals go to the transmitter. "Transmitter" means "sender." The transmitter sends out the radio waves.

Here is where the radio currents are made by big vacuum tubes. The picture signals, along with the up-and-down and back-and-forth signals for the electron beam in your set, and the sound, are all mixed with the radio currents.

The transmitter looks like a big radio set with many knobs and dials. Expert engineers are on duty all the time to make sure that nothing goes wrong and to keep making adjustments to all the complicated parts.



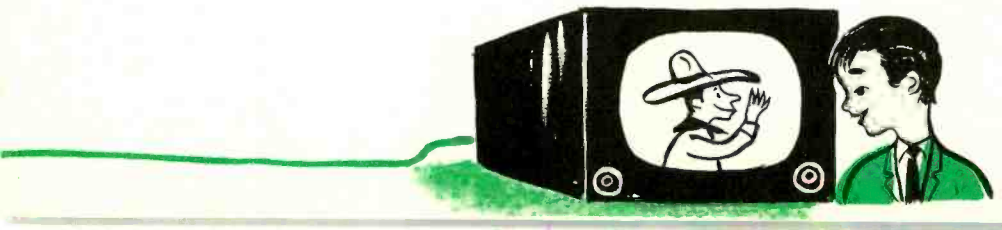
THE ANTENNA

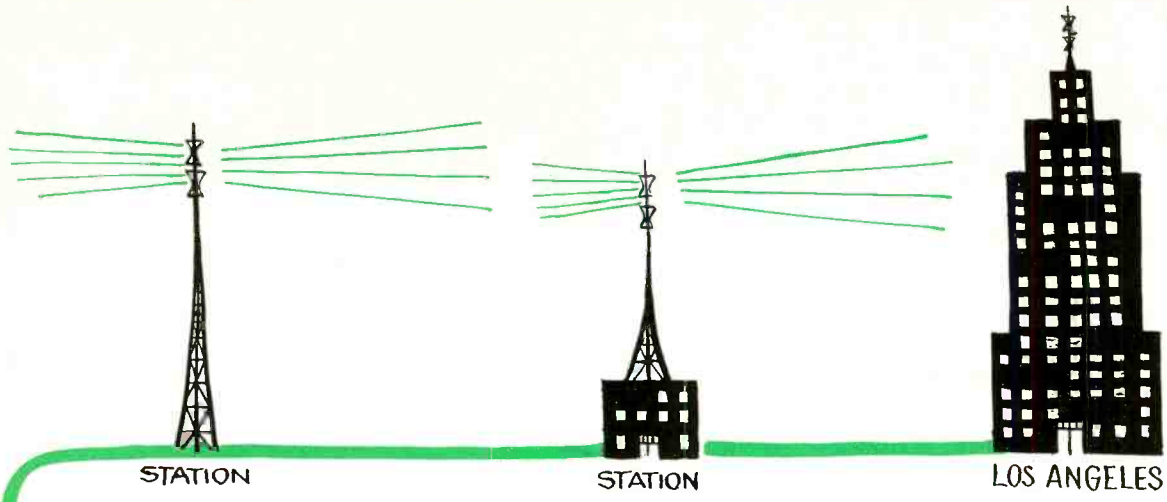
The radio currents go through the special wires called coaxial cables to the antenna. These coaxial cables are wires with a heavy shield all the way around them to keep the currents from turning into radio waves before they get to the antenna.

The antenna is always on the highest place the station can use. In New York, several stations have antennas on top of the Empire State Building, the highest place in the city. Many towns have tall television antennas on nearby hills or mountains.

This is to let the radio waves reach as far around the curve of the earth as they can.

Here, in the antenna, the moving electricity makes the mysterious radio waves that travel through space to the antenna connected to your set.





COAST-TO-COAST TELEVISION

A program may be made in California or New York or Chicago, yet you see it on the other side of the country.

Your receiver does not pick up the radio waves from the station where the program is being made. Instead, the picture signals are sent through coaxial cables to other stations. These stations put the signals through vacuum tubes to make them stronger, because they get weaker when they travel a long distance.

The signals are passed on from station to station. Each station broadcasts the program to the homes near it. You get the program from the station nearest you. The stations all working together are called a "network," such as the National Broadcasting Company or Columbia Broadcasting System or American Broadcasting Company.

And that is how you can see a comedian or actor perform in California or New York or Chicago while you are in Atlanta or Boston or Kansas City!

SPECIAL WORDS USED IN THIS BOOK

ANTENNA. A special wire that turns electric current into radio waves, or radio waves back into current.

CATHODE. The part of a vacuum tube that kicks electrons off into the vacuum.

COAXIAL CABLE. A wire for carrying very high frequency electric current, with a shield around it to keep the current from turning into radio waves.

CONTROL ROOM. The room in a television studio where the signals from the cameras are selected and controlled.

CURRENT. The quantity of electrons moving through a wire.

ELECTRICITY. Electrons moving through a wire.

ELECTRON. A tiny bit of electricity.

ELECTRONICS. Electrons moving through a vacuum.

FLUORESCENT. Shining. Especially, a chemical that glows when electrons hit it.

FREQUENCY. How often a current changes direction or amount. Also, how quickly a radio wave ripples. The *speed* is always 186,000 miles a second.

ICONOSCOPE. A type of television camera tube.

IMAGE ORTHICON. The type of television camera tube described in this book.

KINESCOPE. The picture tube in a receiving set.

MASTER CONTROL. The main control room of a station or network.

ORTHICON. A type of television camera tube.

PHOTO CATHODE. A part in a vacuum tube that kicks out electrons when light hits it.

PHOTO-ELECTRIC EYE. A vacuum tube that makes current flow when light hits it.

PLATE. The part of a vacuum tube that pulls flying electrons out of the vacuum.

REMOTE. A television program made outside the studio.

SCAN. To look carefully at all parts of something in a certain order.

SCANNING BEAM. The stream of electrons in a camera tube.

SCANNING DISK. A disk with holes, used in mechanical television.

SCRIPT. The words to be said and the directions for acting in a program.

SET. The background scene for a program.

SHADOW MASK. The part in a color picture tube that keeps the electron beams with the different color signals from hitting the wrong color dots on the screen.

STUDIO. The place where television programs are made.

TARGET. The part in an Image Orthicon tube that has electrons knocked out of it by the electrons from the photo cathode.

TRANSMITTER. The electronic device that makes the radio-wave current and combines the television signals with it.

TUBE. A glass bulb with a vacuum inside, and different parts for controlling electrons moving through the vacuum.

TUNE. To select one frequency of radio wave.

VACUUM. The lack of anything. In radio and television, a place with the air pumped out.

VACUUM TUBE. The same as "tube."

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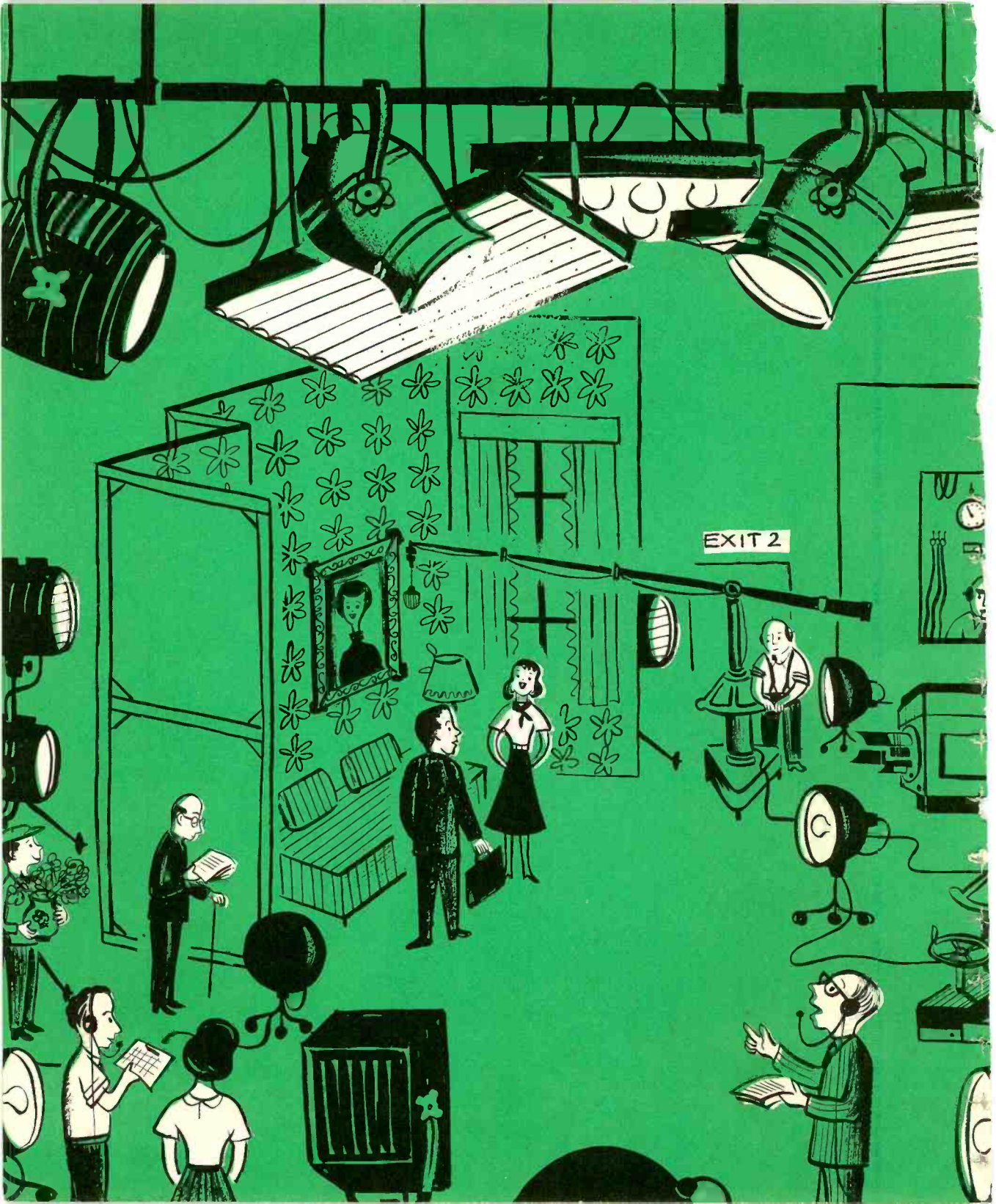
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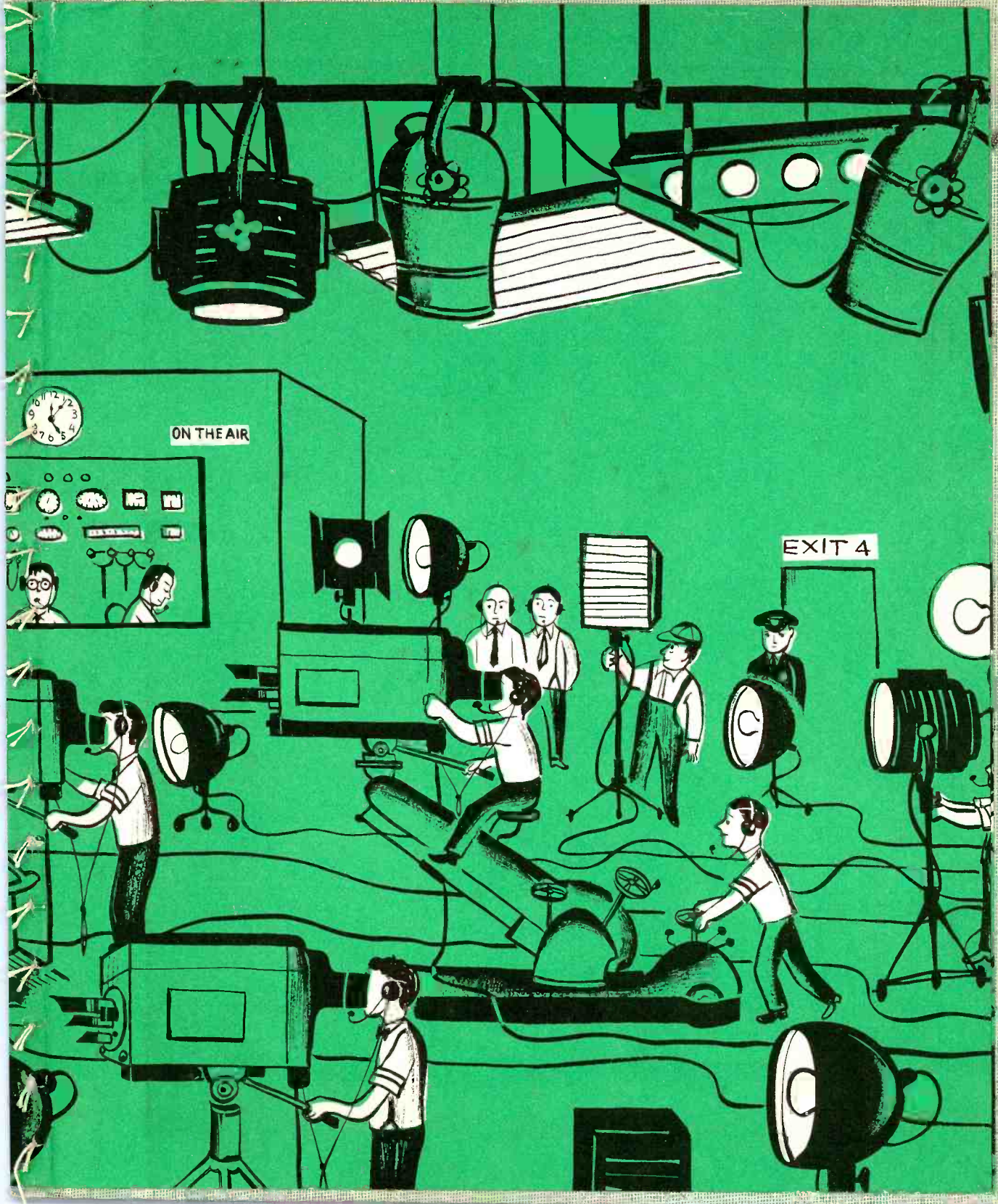
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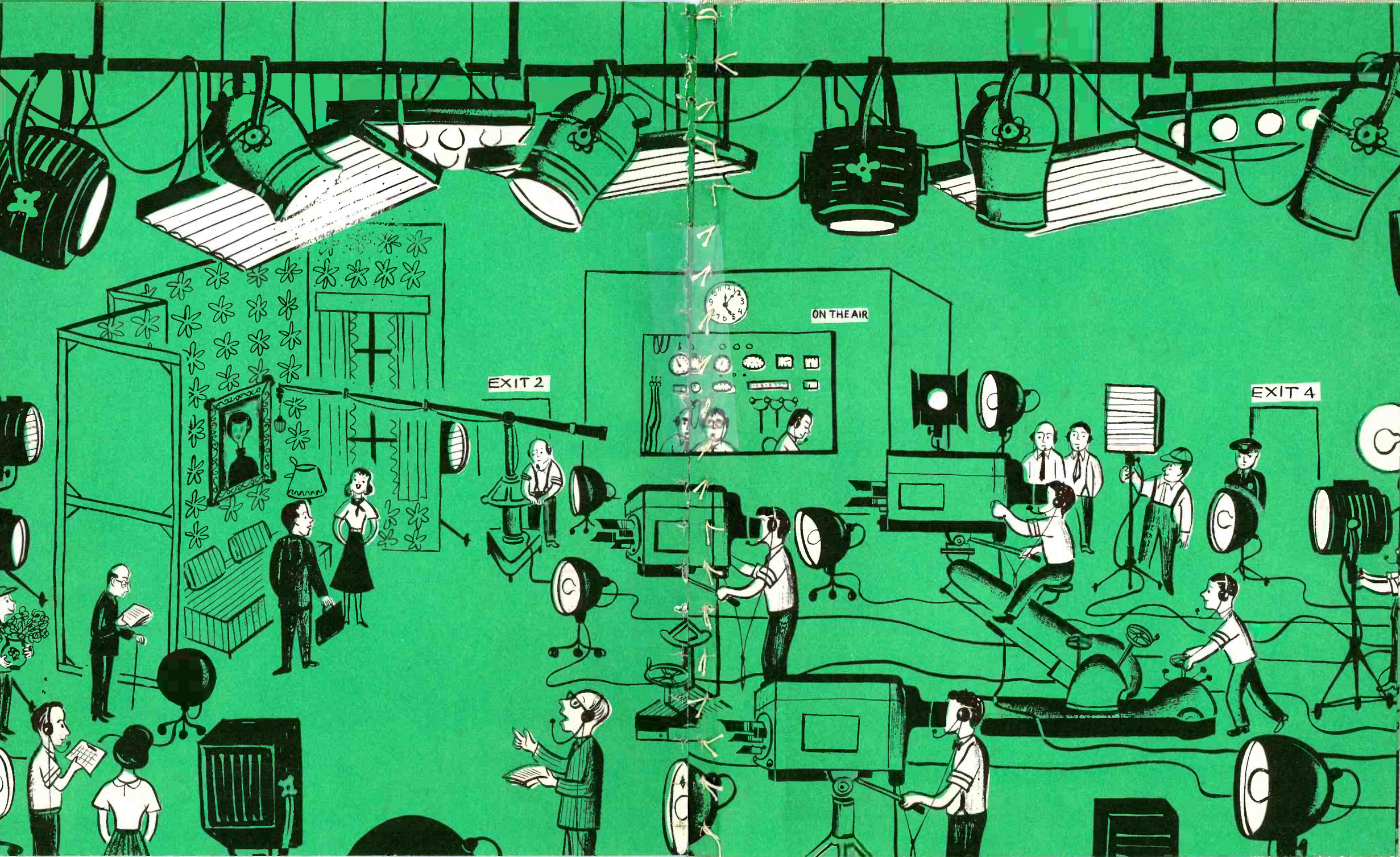
EXIT 4


ON THE AIR
EXIT 4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