TELEVISION

From the collection of the

Prelinger Library

San Francisco, California
2006

TELEVISION

COMPILED BY WORKERS OF THE WRITERS' PROGRAM OF THE WORK PROJECTS ADMINISTRATION IN THE COMMONWEALTH OF PENNSYLVANIA

ALBERT WHITMAN & CO

CHICAGO 1942

PENNSYLVANIA DEPARTMENT OF PUBLIC INSTRUCTION
State-wide Sponsor of the
Pennsylvania Writers' Project

FEDERAL WORKS AGENCY
John M. Carmody, Administrator

WORK PROJECTS ADMINISTRATION
Howard O. Hunter, Commissioner
Florence Kerr, Assistant Commissioner
O. K. Yeager, Acting State Administrator

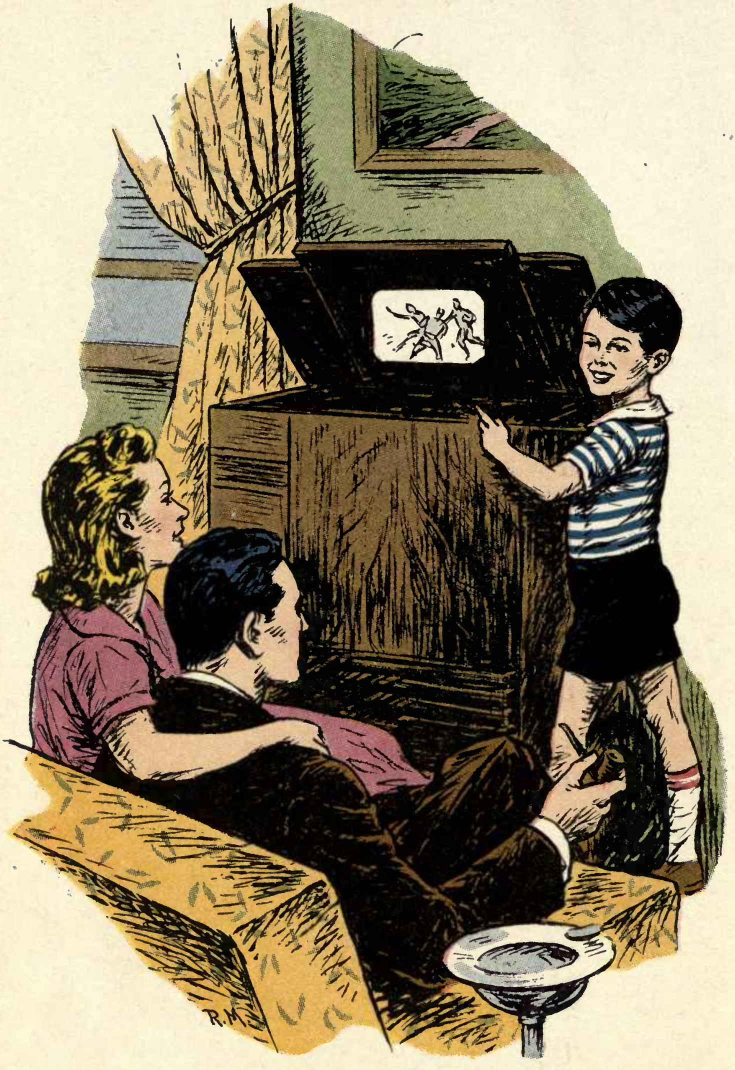
Co-sponsored and copyrighted, 1942, by Division of Extension Education
Board of Public Education, Philadelphia

FOREWORD

Television is the twenty-seventh booklet in the Elementary Science Series. It was prepared by the Pennsylvania Writers' Project which is sponsored by the Pennsylvania Department of Public Instruction. This booklet was written by Katharine Britton. Illustrations were drawn by Reynolds Mason of the Pennsylvania Art Project, under the direction of Michael Gallagher.

Acknowledgment is made to William P. West, Associate Director in charge of Electric Communications, Franklin Institute, Philadelphia, for acting as consultant to assure accuracy of the text and illustrations.

J. Knox Milligan
State Supervisor


R.M.

TELEVISION

A football game. A prize fight. A ballet dance. A swing orchestra. A play, *Death Rides the Range*. A trip through the Metropolitan Museum of Art. All these and many other colorful things a person can see and hear during one week in his own living room. And he can see them at the same time that they are actually happening many miles away.

Is the person who can see such things a magician? Does this seem like something that could happen only in a dream? It is no dream story. This list of events was taken from a newspaper. It is part of a program of television broadcasts. Anyone who lives near New York and owns a television set may really have seen these very things, and many more, in one particular week.

Television is so new and so strange that all of us can still feel the wonder of it. To be able to see far-distant things as they happen was one of the oldest desires of men. For a long time it seemed no more than a dream. People believed it could come true only in story books, or by magic.

But it is not magic. It is the result of men's work. We have it today only because of men's studies and discoveries during hundreds of years. Little by little men gathered knowledge about the world around them and the forces of Nature. At last, just a few years ago, by using this fact and that from their store of knowledge, they were able to create the wonder that we know as television.

The word television is made up of two words. The last part of it we are familiar with. Vision means sight. *Tele* is a Greek word that means far off. So television is seeing things happening at a distance.

Let's stop and think what this really means. Certainly we don't see the actual events happening in distant places. We see moving pictures of them. These picture messages have been carried to us so quickly that we see them almost as soon as do the people on the scene. They are carried by radio, a messenger swifter than lightning. So we must know something about both radio and moving pictures to understand how it is done.

RADIO

A man speaks in Washington and his voice is heard in a split second throughout the United States. That no longer seems wonderful to us. We say that the radio does it. But certainly it is a strange thing that our radios should be able to pick this message out of the skies. There is no connection at all between them and the man in Washington. Why does this far-away voice make our radios speak if they are tuned to the right station?

The message of the voice is carried to us by radio waves. These are waves that cannot be seen or felt. Yet it will not be very hard for us to understand them, for in some ways they act like waves in water. By watching water waves we can find out many things about radio waves.

Suppose the tub in the bathroom is filled with water. At one end of the tub a cake of soap is floating. Now someone moves a stick up and down in the water at the other end. The water around the stick begins to move up and down in little waves. The waves spread out farther and farther. When they reach the cake of soap, this too begins to move up and down in time with the stick.

If the stick is moved up and down more rapidly, the soap moves more rapidly too. If the stick is plunged deeper, the soap moves farther down and farther up. It always moves just as the stick moves. For as the motion of the stick is changed, the waves are changed, and they change the motion of the soap.

THE CAKE OF SOAP MOVES UP AND DOWN IN TIME WITH THE STICK.

The person with the stick can even send simple messages to someone else by figuring out a code. Perhaps moving the stick fast means, "I feel happy, How are you?"

Moving it slowly may mean, "I am tired. Let's stop playing."

By keeping his eyes on the soap, the second person can tell what his friend is saying even though he doesn't look at the stick. And if the person with the stick learns to move it so as to change the waves just as he wishes, many more messages can be worked out.

In somewhat the same way, radio waves are made by electricity surging up and down in the antenna at a broadcasting station. The electricity surges up and down thousands or even millions of times a second. Each up and down surge is called a cycle, and sends out a radio wave.

The radio waves spread out in all directions from the broadcasting station. They move very much faster than water waves. In one second they travel 186,000 miles! That is fast enough to go all the way around the world more than seven times a second.

In any receiving set that is tuned in properly, the radio waves make electricity surge back and forth in time with the electricity surging in the sending set at the broadcasting station. If the station is sending out one million waves a second, the electric current in all these radios flashes back and forth one million times a second. It also grows stronger or weaker as the current in the sending set grows stronger or weaker.

Sometimes the message is sent by changing the number of times a second the electric current in the broadcasting station surges up and down. Sometimes it is done by changing the strength of the surging current.

Suppose a radio station is broadcasting a play. The actors speak their lines into a microphone, which works like the mouthpiece of a telephone. The sound makes the current of electricity flowing through the microphone move in waves that grow stronger or weaker, or sometimes almost die away entirely. This gives its pattern to another electric current, which is surging back and forth in the sending set. Out upon the air flow radio waves bearing the same pattern of changes as the electricity flowing from the microphone.

Through the skies the waves flash. They set up a current with the same pattern of changes in our radios. Then this current is changed back into sound by our radio loud-speaker, which works much like the receiver of a telephone. And we hear the actors read the lines of the play. Electric current can be changed in different ways in order to send different kinds of messages. Men found out how to send sound messages by radio a long time before they found a way to send picture messages over the air.

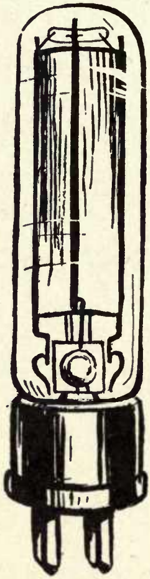
Anyone who wants to learn more about radio waves and how they are used may read the book called *Radio* in this same Elementary Science Series.

RADIO PICTURES

To send a sound message by radio the sounds must first be changed into electric current. In the same way, to send a picture, light must be changed into electric current. For a picture or a scene is really many small areas of light, some brighter, some darker.

Changing light into electricity is not so difficult as it might seem. A number of years ago men discovered that certain materials found in nature produced electricity whenever light rays struck them. The amount of electricity produced depends on the brightness of the light. A strong light makes a large current of electricity. Weak light makes a smaller current. In darkness no current at all is produced. Such materials are called photo-electric. Photo comes from a Greek word meaning light.

Men had found too that the electricity



THIS IS ONE KIND OF PHOTO-ELECTRIC CELL.

produced in photo-electric material can be drawn off through electric wires. The amount of electricity flowing through the wires changes as the amount of light falling on the photo-electric material changes.

Men put their knowledge of photo-electric materials to use in many ways. For one thing, they invented what is called a photo-electric cell. This is one

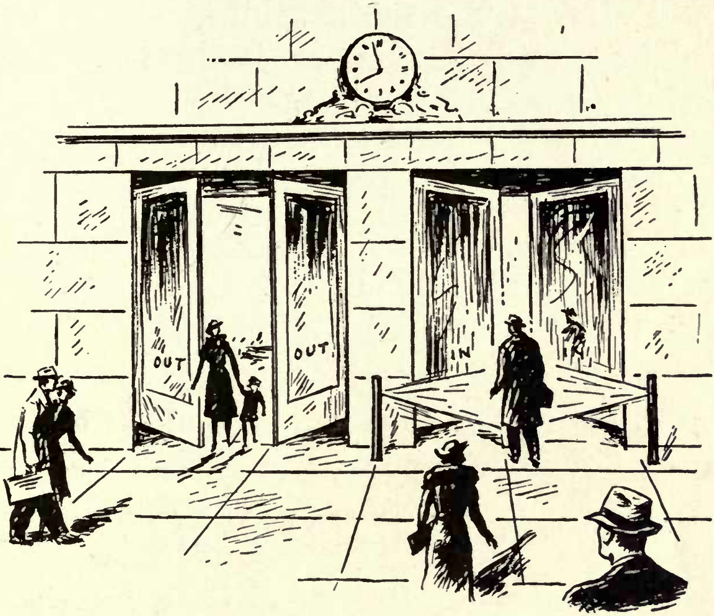


PHOTO-ELECTRIC CELLS ARE USED IN OPERATING THESE DOORS.

of the most wonderful of all of today's inventions.

Some photo-electric cells look much like electric bulbs. Each has a metal plate inside the glass and this is coated with photo-electric material. There is an arrangement of wires to lead off the electricity produced when light enters the cell and strikes the metal plate.

The photo-electric cell is used in operating those doors that seem to open of themselves when we come up to them. It has many other uses. But a simple cell cannot be made to carry a message of a picture. For instance, if a person should stand before a photo-electric cell, he would cast a shadow on the cell. This would change the amount of electric current flowing through the wires, but the whole image of the person would affect the cell at once. There would be no way of telling from the amount of current produced what the different parts of the person's face were like.

The men who were working on television had a very clear idea of what they had to do to send a picture message with a photo-electric cell. They had to find some way of making the cell measure the light from each part of the picture separately.

EVERY PICTURE IS MADE UP OF DARKER AND BRIGHTER AREAS.

To understand exactly what this means, let us get a picture from the newspaper and cut it up into many parts, as fine as possible. Then if we pick up the pieces one by one, we can no longer tell which part of the picture each one comes from. The only difference among them is that some are darker, some brighter.

If Mother decided now that we must put the picture together again, we should really be in a nice fix. We shouldn't be able to do it no matter how long and hard we tried.

Yet this is just about the problem that the television men had to face. They not only had to find some way of changing the light from each part of the scene or picture into changing electric current or electric waves; they also had to have some way of keeping the electric waves in the proper order. Then the electricity could be changed back into small dots of light arranged so as to form the picture.

One way of sending photographs by means of the photo-electric cell is this:

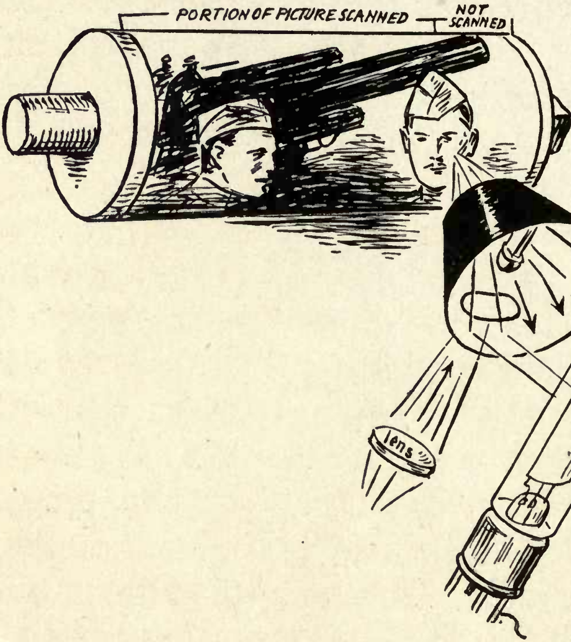
The film of the picture to be sent is

wrapped around a glass cylinder. A cylinder is shaped like a tin can. But the cylinder holding the picture is much larger than an ordinary tin can. This cylinder turns around and around on a pole. At the same time, it moves lower on the pole little by little, just as a nut turns on a screw.

When the glass cylinder first starts to move, a very bright ray of light from an electric lamp is pointed at one spot on the bottom of the picture. This ray of light remains still, and slowly every bit of the picture passes under it. We say that the ray of light has scanned the picture.

Inside the turning cylinder is a photoelectric cell. The ray of light shines through the film and the glass upon this cell. When bright parts of the film are passing under the ray, a strong light shines upon the cell. Then the current from the cell is also strong. But when the ray passes over darker areas, only a little light shines through, and the current from the cell becomes weak.

The changing current from the cell



THIS IS ONE WAY OF SCANNING A PICTURE. THE LIGHT REFLECTED FROM EACH SPOT OF THE PICTURE SHINES UPON THE PHOTO-ELECTRIC CELL ON THE RIGHT.

flows through wires or is sent out over the air by radio waves. At the end of its journey, there is another cylinder turning exactly in time with the sending cylinder. Around this second cylinder is wrapped a piece of fresh film. In front of the cylinder is a special kind of electric bulb, which casts a ray of light on the film. The changing current sent out from the first cylinder travels along the wires of this bulb. As the current becomes stronger or weaker, the ray of light flickers, becoming brighter or dimmer. And as it flickers, it makes changes in the film on the cylinder just as light makes changes on film in a camera. It really makes a picture.

This method of scanning a picture works very well, and it gives a very true image. But it takes about eight minutes to send one picture. For this reason it cannot be used in television. For the moving pictures that we see in television are really separate pictures. Thirty of them are flashed on the television screen every second.

If one happens to know something about motion pictures, this will be less surprising. For moving pictures on the theater screen are also separate pictures, flashing one after the other before our eyes.

There is no camera that could take pictures in which the people or things are *actually* moving about as we watch. They only seem to be moving. The camera takes thirty different pictures of a scene every second. In each picture the scene is shown just a little differently from the one before it. It may take ten pictures for a man to make one step. But when these pictures are run off before us at the rate of thirty a second, we see them all as one *moving* picture.

The reason for this strange thing is that our eyes hold any picture message for about one-tenth of a second. By the time one picture has faded from our eyes, another has taken its place on the screen, and we do not see them separately.

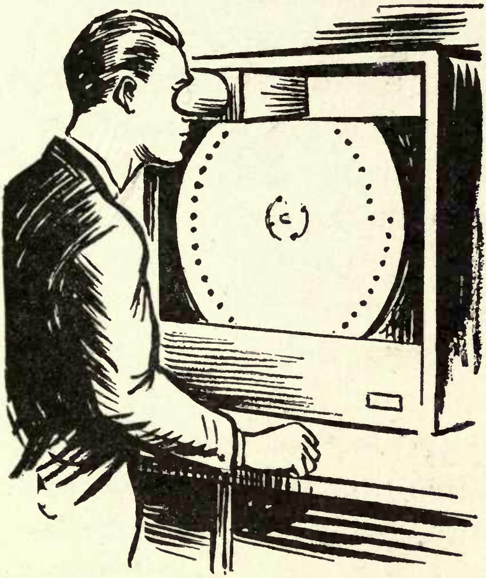
There is a simple way of showing how this happens. On one side of a white card draw an animal. On the other side of the card draw a cage Now tie a string to the center of the card at the top and another to the center at the bottom. Hold the card by two strings and blow on it so that it whirls around and around. The animal looks as though it were in the cage. This is an illusion. An illusion is something that seems to be different from what it really is.

The picture on a moving picture screen, or a television screen, also gives us an illusion. It is called the illusion of motion. Another book in this series, called *Motion Pictures*, tells a great deal more about this and the other ideas used in motion pictures.

Since a number of pictures must be sent out every second in order to televise a scene, the scene must be scanned very, very quickly. The first successful way of doing this was shown to the world in 1925. Besides the photo-electric cell, this method used what is called a *scanning disk.* The scanning disk itself was not new. The idea was first worked out forty years before that by a man named Paul Nipkow.

A disk is anything that is round and flat, like a plate or a phonograph record. The scanning disk has a number of holes cut in it, placed like those in the picture on this page. Each hole is just a little bit closer to the center of the disk than the hole before it. The disk faces the scene to be televised and whirls around and around like an electric fan.

Behind the disk is a very bright light. This light shines through the whirling holes. First the outside hole whirls by, and the light moves like a pencil over the top of the scene. Then the next hole



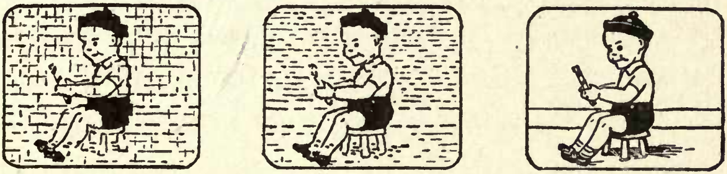
THIS MAN IS LOOKING IN AT THE SCREEN OF A SCANNING DISK RECEIVING SET.

whirls by, and the beam of light flashes across another section of the scene, just below the first. When sixty holes have whirled by, the whole scene has been scanned once. Then one whole picture has been sent out.

The disk is moving rapidly enough to send out perhaps thirty pictures a second. The beam of light moving across the scene is reflected now strongly, now weakly, depending on the brightness or darkness of each picture of the scene. These changing reflections are picked up by two sets of photo-electric cells. From the cells flow a changing current of electricity, to be sent out over wires or changed into modulated radio waves.

The receiving set has a disk with holes placed just like those in the disk at the television station. The two disks whirl in exact time with each other. Behind the receiving set disk is an electric bulb whose light shines through the holes upon a small screen. The beam of light flickers as the changing current flows through the electric bulb. This flickering beam of light paints thirty pictures every second upon the screen.

Of course the person watching the screen doesn't see the pictures being made, and he doesn't see them separately. His eyes are too slow. What he sees is the scene that is being broadcast, or as we say, telecast.



THESE DRAWINGS SHOW HOW A PICTURE BECOMES CLEARER AS THE NUMBER OF SCANNING LINES BECOMES GREATER.

By learning how the scanning disk works, we can understand many of the ideas that are used in television. Then we shall understand more quickly the system of television now in use in America.

TELECASTING IN AMERICA TODAY

The scanning disk system has several big faults. For one thing, it has moving parts. They wear out quickly or get out of order and must be repaired. Another trouble is that the electric light behind the disk in the receiving set is a neon light. This is the kind of light used to light many signs at night. Neon light is bright pink or red in color. So the moving pictures in the television screen are pink and black instead of white and black. This not only looks strange to the person watching, but it makes his eyes very tired.

Besides this, the pictures telecast by the scanning disk are not very clear. All the different small parts in a scene do not show. This is because the disk breaks up the scene into only sixty to ninety strips. So all the differences of light and shadow in the scene cannot be caught.

Because of these things, many people believed that it would never be possible for television to become as important in our lives as radio has become. Yet today we have a system so good that it has already brought television into many homes.

In this new system, the scanning is done inside a very special type of camera called a television camera. On the outside, the television camera looks much like a very large newspaper camera. It is a box-like thing that stands on three legs. It has a "glass eye" in front like any other camera. But inside it is very different.

The thing that makes the television camera different is an invention called the iconoscope. The iconoscope is a large glass bulb from which almost all of the air has been removed. The light from the scene being televised enters the iconoscope through the glass eye of the camera. It strikes a square metal plate in the back of the iconoscope. This metal plate is covered with millions of tiny particles of photo-electric material. Each of these tiny particles at once produces a certain amount of electricity, depending on the amount of light that falls on it. The scene before the camera has been captured in an electric picture.

Down in the narrow neck of the iconoscope is something called an electron gun. This electron gun shoots a stream of electricity at the metal plate just as a garden hose sprays water on the lawn. This stream of electricity moves left across the top of the metal plate. Then it moves back to the other side along a path slightly below the first one. Back and forth it goes like this, until every bit of the metal plate has been scanned.

This moving stream of electricity, called an electron beam, strikes the tiny photo-electric particles one after the other. As the beam strikes each one, a certain amount of electricity flows from the metal plate. This is called one signal. Each signal moves along through the wires leading to the transmitting set, which will send out the radio waves over the air. The strength of a signal depends of course on the amount of electricity that the light from the scene has left in each photo-electric particle.

The electron beam moves back and forth 525 times for each picture. Along each of the 525 lines it sends out several hundred signals of different strength. Since the beam scans the whole metal plate thirty times every second, it sends out a million or more signals every second. It has to move very rapidly to do this. From left to right it moves at a speed of two miles a second. Returning from right to left it moves twenty miles a second. That is a speed of 72,000 miles an hour.

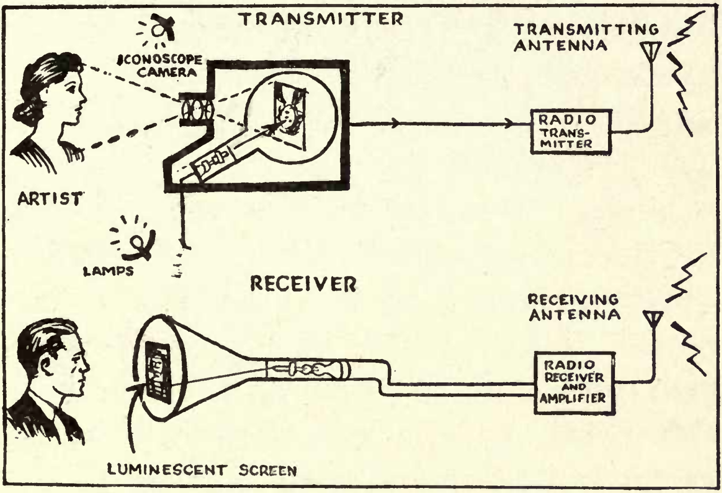
Along the wires leading to the transmitting set flashes the changing electric current, bearing these millions of signals. There the pattern of the signals is given to another electric current, which is already surging back and forth millions of times a second. The radio waves made by the surging current carry the message of the signals through the sky. They are picked up by any television receiving set that is close enough and is tuned in properly.

THE TELEVISION RECEIVING SET

A television receiving set has many more tubes than an ordinary radio set. Some of these tubes strengthen the surging current produced by the radio waves sent out from the television station. Otherwise this current would be much too weak to produce a good picture. The radio waves bearing the signals become weaker the further they spread out from the broadcasting station.

Other tubes act in such a way that when the current leaves them it is flowing in waves just like those that flowed from the millions of tiny photo-electric cells in the television studio.

Besides all these tubes, there is one big glass tube. The task of this tube is to change electric current back into light and so make pictures. Like the icono-



scope, the tube has an electron gun down in its narrow neck. The top of the tube is flat. It is made of a material that acts just the opposite from photo-electric material. Instead of producing electricity when light falls upon it, this material gives out light when electricity strikes it. In other words, it is luminescent. This luminescent material forms the screen on which the moving pictures are produced.

The current in the receiving set, flowing just like the current sent out from the iconoscope, makes the electron gun shoot a beam of electricity at the screen. This beam changes exactly as the current changes. It moves in time with the beam in the iconoscope. When the electron gun is shooting at a certain spot on the metal plate of the iconoscope, and a strong current is flowing from that spot, the beam of the electron gun in the receiving set is shooting a beam of electricity of exactly the same strength at exactly the same spot on the screen of the receiving set.

The beam of electricity, changing in strength as it moves back and forth across the screen, makes each spot that it touches glow. The brightness of the glow depends on the strength of the beam. And so a picture appears on the screen, a picture of the scene that is being telecast.

TELEVISION IN COLORS

At first only black-and-white pictures could be sent by television. The iconoscope could not separate the different colors of the scene. The television receiving set was color-blind.

That is no longer true today. Men know how to capture all the colors in a scene and send them over the air. They are still testing out this idea, and color receiving sets are not yet in use in our homes. But it is quite possible that some day all television moving pictures will be in natural colors.

To send color pictures something new had to be added to the television camera. There was no way of making the photoelectric particles in the iconoscope see all the different colors in a scene. They could measure only the amount of light that struck them, not the color of that light.

The new part of the color television camera is an arrangement of three thin sheets of a material that looks like gelatin. It actually is gelatin prepared in a special way. Through these sheets of gelatin light can pass. One sheet is red, another blue, another green. They are called filters.

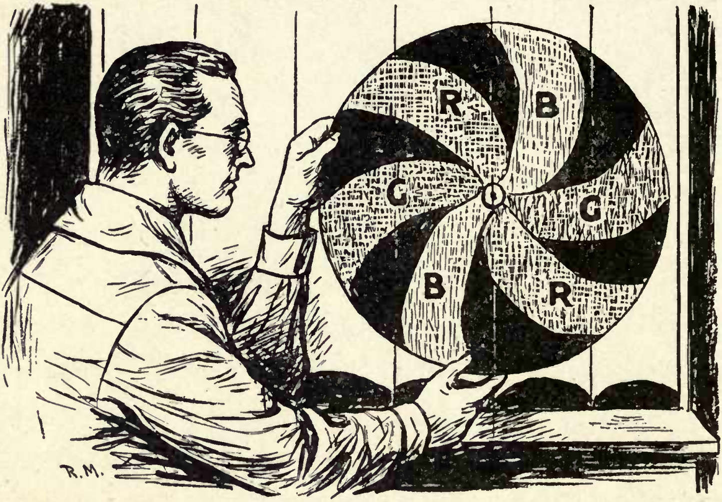
The three filters revolve before the metal plate of the iconoscope. First one, then another, then the third passes before the plate. The electron gun scans the metal once while the red filter is before it. Then it scans the plate while the green filter is before it, and again when the blue one is before it.

The light passes differently through each of the colored filters. So the message sent out through each one is slightly different from the other two. The three different picture messages are going to be put together in the television receiving set to make one single colored picture.

Because each group of three pictures taken through the revolving filters makes only one color picture, the electron beam has to work very rapidly. Instead of sending out thirty pictures a second it must send out three times as many, or ninety.

In the television receiving set is a disk made up of three colored filters. This disk revolves like a phonograph record. Each filter passes before the screen at exactly the same instant that the filter of the same color passes before the iconoscope plate in the sending station. A red filter covers the screen of the receiver at the same time that the iconoscope is sending out the message received through its red filter.

Through each filter a picture of different color is thrown on the television screen. But the person watching does not see the separate pictures. Through his eyes they become one picture, and even this he does not see as one separate picture. Ninety pictures, or thirty groups



A DISK MADE UP OF FILTERS OF THREE DIFFERENT COLORS IS PLACED IN THE RECEIVER SET.

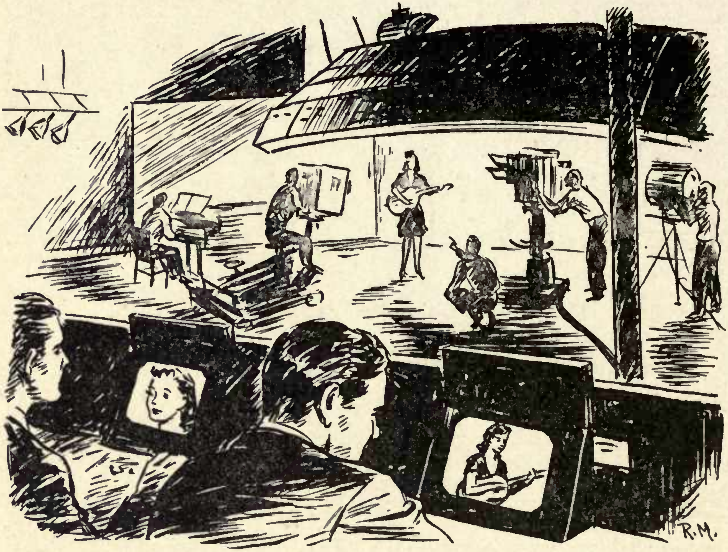
of colored pictures, are flashed before him in one second, but he sees only a moving picture in full color.

How can he see full color when only red, blue, and green filters were used?

Well, these three colors have been mixed to form other colors. We all know something about how this happens from working with colored crayons. With just two or three colors many more can be made. Blue and red make purple. Blue and yellow make green. Red and yellow make orange. In the same way, the three colors of the filters mix on the screen to make all the colors of the scene.

WATCHING A TELECAST

A television studio looks much like a moving picture studio. It is very brightly lighted. Here and there are pieces of scenery and many articles of stage property. Costumes lie ready, so that changes from one to another can be made with lightning speed. Three television cameras are set on small rubber-tired moving platforms called dollies. On the dollies the cameras can be moved wherever they are needed. Overhead on a long moving arm is the microphone. This too can be moved about to follow the performers. It will pick up the sounds of the programs at the same time that the



ENGINEERS IN A CONTROL ROOM WATCH TO MAKE CERTAIN THAT THE TELECAST IS GOING ALL RIGHT.

camera takes the pictures. Then both sounds and pictures will be sent out together by radio waves.

The director of a television play or

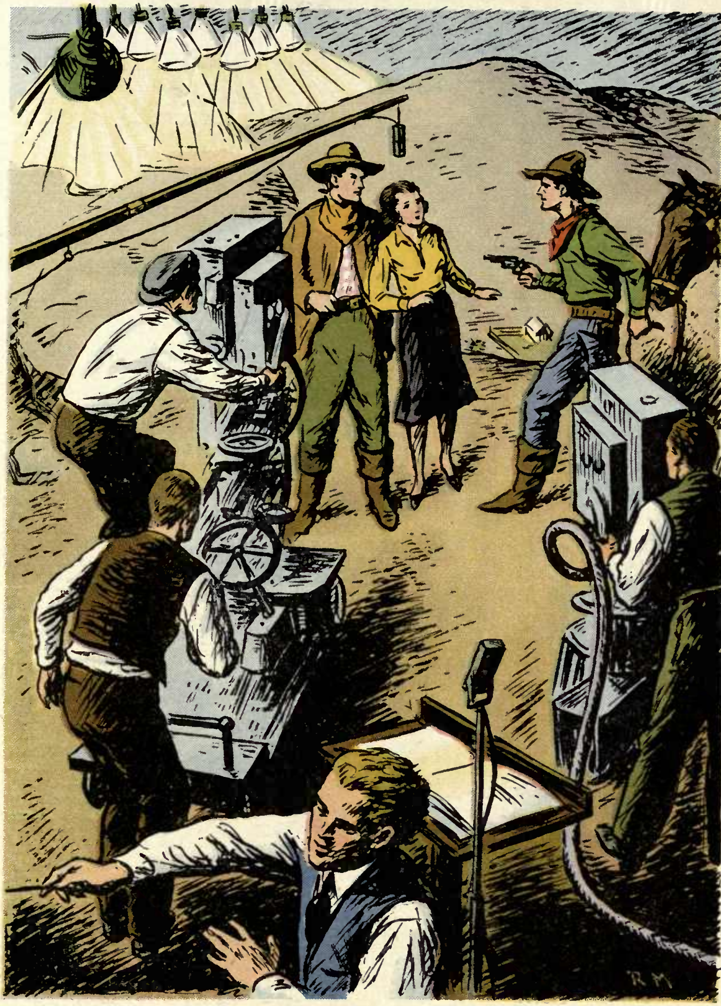
program not only has all the problems of a moving picture director and a radio play director. He also has other problems that neither of them has.

For instance, he has to make certain by silent signs that his actors do not walk out of range of the camera. If they do, the watchers will see them suddenly disappear from the television screen. So the floor of the studio is carefully marked to show the actors just how far they may go. If a mistake is made, the scene cannot be done over, as it can in the movies. The sharp eye of the television camera will catch the fault and broadcast it to the world.

Another problem is that sound effects—like thunder, a railroad train, or an automobile crash—cannot be made close to the microphone, as they often are in ordinary radio. The sound effects man must keep his strange contraptions out of the way, so that they cannot be seen by the cameras. Sometimes the sounds have to be made in a different room. Then they are matched, or synchronized, with the telecast in the control room.

One of the most difficult problems of all is finding suitable actors. Of course, the actors must be able to do the parts well. They must have the right voices, and the right appearance. But that is not all. Television actors must also be the right size. They have to be rather small and thin. Anyone large or tall looks like a giant on the small television screen, and the other characters look like dwarfs beside him.

Besides that, the actors must be dark-haired. The darker the hair the better it televises. Sometimes the head of a very blond person does not televise at all. Usually the blond head appears, but there is a circle of pale light around the head not only of the blond person, but also around the head of anyone near him. For



this reason blondes are known in television as blizzard heads.

Blondes cannot even help matters by dyeing their hair. Dyed hair televises muddy and dead-looking.

One thing that is no problem for the director today is the makeup of the performers. In the early days, however, this was one of the worst problems. The television camera was so poor that it caught only very great differences in light strength. So the actors had to cover their faces with heavy white grease. Their lips were painted black and their eyelids were painted very dark. This made them look so strange and funny that it was hard for them to act well. Even with this heavy make-up, the lights had to be very very bright. They gave off so much heat that the actors became very warm and perspired under their heavy make-up.

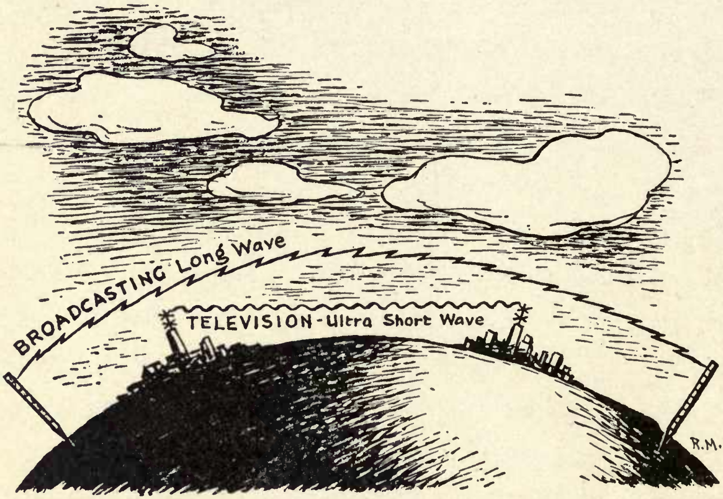
Today the television camera sees even

very small differences of light. Besides that, the lights in the studio have been made much better. It is possible to get very brilliant lights that produce little heat. For these reasons, no more make-up is needed than a girl would wear on a bright sunshiny day outdoors.

BEYOND THE HORIZON

There is one problem of television that has not yet been solved. Men have not found a way to telecast very long distances at low cost. The radio waves used in television act somewhat differently from those used in ordinary broadcasting. They are very short waves. This means that the distance between the crest of one wave and the next is small. The shortest radio waves are no longer than the distance a child could throw a rubber ball. The waves used in regular radio broadcasting are from a few yards to three city blocks long.

Longer waves travel along following the earth's curve. But short waves travel more in a straight line. They are generally lost beyond the horizon, as the



THE SHORT WAVES USED IN TELEVISION ARE LOST BEYOND THE HORIZON.

diagram on this page shows. The horizon, of course, is the place where the earth meets the sky. The short waves used in long-distance radio broadcasting bounce back to earth again very far from where they started. But the very short television waves do not do this.

Usually television waves carry their message fifty or sixty miles. Sometimes they carry it one hundred miles. The only way today to carry television pictures much farther without using wires is to build what are called booster stations about fifty miles apart. These booster stations can pick up the waves, strengthen them, and send them on the next lap of their journey. The only trouble with this plan is that it is costly.

Yet it is very likely that within twenty years or so men will find a simple way to send television broadcasts as far as radio broadcasts. We know that this may be possible because once some very faint pictures from a program telecast in England were picked up on the Atlantic coast of America. At other times strange pictures from across the seas were seen in testing stations in our Far West.

No one has yet found out exactly why these television broadcasts carried so far. But men will keep on testing and trying to find out, until they do discover what caused these freaks. Then they may discover also a way to repeat the strange happenings whenever they wish.

The mystery of the freak telecasts shows how far men have still to go before they learn all the secrets and all the uses of radio waves. But it is thrilling to think about the exciting adventures that lie ahead in this search, and the wonderful things it may bring about.